

**Xactware Solutions, Inc.**

**EXHIBIT 1007**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE PATENT TRIAL AND APPEAL BOARD**

In re <i>Inter Partes</i> Review of:	:
U.S. Patent No. 8,078,436	:
	:
Issued: December 13, 2011	:
	:
Named Inventor: Pershing et al.	:
	:
Patentee: Eagle View Technologies, Inc.	:
	:
Filed: October 16, 2008	:
	:
Title: AERIAL ROOF ESTIMATION	:
SYSTEMS AND METHODS	:
_____	:

**DECLARATION OF HAROLD SCHUCH**

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## **I. Introduction**

1. I, Harold Schuch, have been retained by counsel as an expert for Xactware Solutions, Inc. (“Xactware”), and I make this Declaration in support of a petition for *inter partes* review of U.S. Patent No. 8,078,436 (the “‘436 Patent”). I understand that my Declaration will be submitted in connection with Xactware’s Petition for *Inter Partes* Review of U.S. Patent No. 8,078,436 (the “Petition”).

2. Sections II and III of this Declaration discuss my Qualifications and the Materials Considered, and my *curriculum vitae* is provided as Attachment A.

3. Section IV of this Declaration provides a short summary of my understanding of the history of photogrammetry.

4. Section V of this Declaration focuses on my understanding of the technical teachings of the ‘436 Patent.

5. Sections VI-VIII focus on how a person of ordinary skill in the art would understand the technology of certain references cited by the Petition.

## **II. Qualifications**

6. I am a professional engineer in the state of Colorado (License No. 22302) and a photogrammetrist certified by the American Society of Photogrammetry and Remote Sensing (ASPRS) (Certification No. 528). I am also an active member of ASPRS, and Member of the Board of Directors of ASPRS-Rocky Mountain Region.

7. I am a consultant in the field of geomatics, with particular experience in geodesy, photogrammetry, geographic information systems (GIS), and global positioning system (GPS) technology. In this regard, I am the principal and owner of GeoCounsel, Inc., which provides consulting services in the fields of engineering, mapping, and cadastral projects.

8. I received a Bachelor of Science degree in Geodetic Sciences and Photogrammetry from the University of Ryerson in Toronto, Ontario, Canada (accredited by AACRAO) in May of 1975. I also received a Master of Science degree in Photogrammetry and Remote Sensing from the University of Washington in Seattle, Washington, USA in December of 1976. Additionally, I completed postgraduate coursework in Hydrology and Hydraulics while a Ph.D. candidate at Colorado State University in Fort Collins, Colorado, USA.

9. I have authored over two dozen technical articles on the subject of photogrammetry, and am a co-author of the book “GIS Data Conversion Handbook,” Glenn E. Montgomery, Harold C. Schuch, 1993, ISBN 0-9625063-4-

6. GIS Data conversion refers to activities that deal with the conversion of data from one form to another, such as extracting vector data from paper maps or raster images, related geo-referencing and quality control.

10. I am a lecturer at the University of Colorado, where I teach courses in Civil Engineering and Engineering Surveys. Additionally, I created and teach a

17-part Internet course in Geodesy and Photogrammetry. I have acted as an instructor for various courses, from GIS project design and management to comprehensive geodesy and photogrammetry curricula. I have done so in 3 languages and in 5 countries.

11. I have extensive experience in connection with computer-based photogrammetry systems and technology. In 1979, I developed the first absolute orientation software for stereoplotters, which helped automate over 100 systems, including two for the United States Geologic Survey (“USGS”) plotter lab. I have managed several large photogrammetric projects, including acting as an official member for World Bank missions to Argentina to help manage cadastral GIS projects spanning 19 provinces. I also helped implement some of the largest GIS solutions in Latin America. Further, I have worked in 16 countries supervising large photogrammetric projects and performing photogrammetric services. In 1982 I developed the first comprehensive cadastral GIS for export to Mexico, for which I was awarded the 1985 Colorado Governor’s award for excellence in exporting.

12. I do not have any financial or other interest in the outcome of this *inter partes* review proceeding or in any of the parties to these actions. My hourly rate is \$420/hour plus expenses, and my compensation does not depend in any way

upon the contents of this Declaration, the outcome of this proceeding, or the results of my service as an expert.

13. Based upon my years of education, certification, background, and experience, I am fully qualified to submit this Declaration.

14. Additional details concerning my qualifications can be found in my attached *curriculum vitae*, which is attached hereto as Attachment A.

### **III. Materials Considered**

15. In forming the opinions expressed in this Declaration, I have considered the following documents:

- (1) the '436 Patent (Xactware Exhibit 1001);
- (2) U.S. Patent No. 8,145,578 (the "'578 Patent") (the '578 Patent is a parent of the '436 Patent);
- (3) Ex Parte Reexamination Certificate Issued on August 27, 2014 on the '436 Patent (Xactware Exhibit 1002);
- (4) the Petition including those Xactware exhibits that are cited by this Declaration;
- (5) a published article by Hsieh entitled "Design and Evaluation of a Semi-Automated Site Modeling System" (Xactware Exhibit 1004) ("Hsieh"); and

(6) a published manual by Applicad, Ltd., entitled “Product Bulletin – November 2002: Key features of our Roofing Software” (Xactware Exhibit 1005) (“Applicad”).

#### **IV. The Field of Photogrammetry**

16. Quoting the Manual of Photogrammetry, Fourth Edition, 1980, ISBN 0-937294-01-2: “The word ‘photogrammetry’ came into general usage in the United States about 1934 when the American Society of Photogrammetry was founded, although the term already had been widely used in Europe for several decades. It is derived from three Greek words, photos meaning light, gramma meaning something drawn or written, and metron meaning to measure, or, in combination, meaning ‘measuring what was drawn with light.’”

17. Photogrammetry is the science of collecting aerial or satellite images, processing them, and extracting information from them in the form of interpretations or measurements. It is the study of the use of photography or imagery to measure or map objects.

18. For example, all the official USGS national maps (“Quad Sheets”) were produced through the use of photogrammetry since early in the 1900s. A core part of the abilities of all photogrammetric systems is the measurement of distances between objects, and heights of objects.



19. Photogrammetry came into being in parallel with the development of cameras in the 1800s, and was first an outgrowth of mathematics, mechanics, and physics (especially optics). The first optical-mechanical mapping instruments were introduced during the First World War. Since the late 1970s, photogrammetry benefitted significantly from the introduction of computers, and since then it is used regularly for local, regional, national, global, and extraterrestrial mapping (e.g., Mars) by the National Aeronautics and Space Administration (NASA), Federal Emergency Management Agency (FEMA), Environmental Protection Agency (EPA), Bureau of Land Management (BLM), etc., and the private sector.

20. A routine and core activity within photogrammetry is the execution of a “block adjustment,” sometimes identified as “triangulation,” (*see, e.g., Hsieh*, p. 1) which uses mathematical relationships to calculate the position of blocks of images, resulting in the precise positioning in three dimensional space, such as a State Plane Coordinate System (SPCS). This permits the collection of mapping detail in that space, including the measurement of distances in ground units (e.g. feet). The standard result of these block adjustments is the calculation of the position in space from where each photograph was taken (X, Y, Z) and the “space angles” that express the rotation of the camera (the direction of the look angle for each photograph -  $\Omega$ ,  $\Phi$ ,  $K$ ). In essence then, block adjustment creates a scaled

and leveled environment within the photographs that allows for the collection of scaled and leveled detail.

21. I am the author of a block adjustment software package, developed in 1979, identified as the “HASP Absolute Orientation for Stereomodels,” and the “HASP Independent Model Adjustment.” Since the early 1980s, block adjustments have been undertaken routinely for either stereoscopic or oblique photogrammetric mapping and/or measurements.

22. Many of the techniques of photogrammetry are extremely well known or common knowledge, and have been for decades. In particular, it has been well-known that the shape and dimensions of an object can be determined using relative points of the object across two or more images (whether stereoscopic or non-stereoscopic). For example, triangulation is a well-known technique, the results of which can be used to determine the relative position and distance between points using two or more images.

23. These principles were historically applied, and can still be applied, by hand using nothing more than paper and a pencil. Since the advent of computers, computer technology has been used in the field of photogrammetry to increase the accuracy and efficiency of processing photogrammetric calculations, and to

facilitate generation of models<sup>1</sup> thereon. Starting in the late 1970s, with the advent of desktop computers, semi-automatic and automatic computer programs were developed to further improve the processing efficiency of the user and the computer in conducting photogrammetric calculations and generating models.

24. Photogrammetric techniques have been used prior to the filing date of the '436 Patent to measure features of buildings, such as roof features. From the beginning of the use of mechanical-optical instruments ("stereoplotters") during the first World War, it was important to be able to measure and count enemy emplacements, including the counting of aircraft in hangars by counting the buildings and measuring the roof outlines to determine aircraft sizes. Additionally, vertical and oblique aerial imagery was reported to be used as early as 1859, for aerial reconnaissance from hot air balloons.

25. Photogrammetry has always been a three-dimensional science and technology. For example, it was used to determine and map a good landing location for the Apollo 11 Program Moon mission (1969).

26. Since then, photogrammetry has been used for a vast variety of applications, including the measurement of the motion of human bones inside living patients using X-ray images, the reconstruction of road accidents, crime

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<sup>1</sup> The term "model," as used herein, refers to the shape of an object as extracted from photographs or images, as in a digital "wireframe" of a building or roof outline.

scenes and insurance claims, and the mapping of high water marks (EPA) and the verification of reclamation efforts as undertaken by open pit mines, etc. This includes the continuing and significant efforts to capture architectonic detail of historic buildings for the purpose of maintenance, reconstruction, or historic record keeping.

27. As such, the mapping of roof details is only one small portion of all the various types of data collection that has been done, and is currently being done, with photogrammetry. This is a consistent necessity, since in most aerial mapping applications, roofs represent the only detail that can be seen clearly from the air, while other details like walls and windows are normally obscured by roof overhangs and/or vegetation, unless oblique imagery is used.

28. Throughout most of the past century, the USGS created maps for the whole of the U.S. territory using photogrammetric mapping extensively, resulting in the general availability of the USGS Quad Sheets. In support of this effort, the USGS extensively utilized “vertical photography,” or photography that was taken with the camera pointing towards the ground, within 10 degrees of vertical. This created the impression that vertical photography was the norm, which masked the reality that other photography of the ground was taken from various angles, other than vertical. In contrast to “vertical photography,” the term “oblique” is a

technical term in photogrammetry which specifically means non-vertical photography.

29. Initially, as during the World Wars, photogrammetry was applied to vertical photo pairs, or two photos covering the objects to be mapped stereoscopically. However, since the advent of computers, the use of multiple images became popular, allowing detail to be collected from all sorts of directions, from the top, the sides, and even from below. The use of these very different “look angles” prevent the stereoscopic viewing and measurement of photographs. When photography or imagery of an object is taken not vertically to the ground, but from various directions, e.g. from the East and from the South, then this is called “convergent” imagery, because the look angles converge toward the object.

30. A functionality provided by photogrammetry includes the automated, semi-automated, or manual matching of image details (e.g., roofs) across multiple images. This functionality is well-known, and has been implemented in the past, for example, using “epipolar” lines, which is a core mechanism in photogrammetry. This has been used industry-wide for many years and is described in a number of prior art references, such as Hsieh.

31. The field of photogrammetry includes the activities such as data conversion, geo-referencing, and vector data extraction (e.g., edge detection).

## V. The '436 Patent

32. I have carefully reviewed the '436 Patent, including the claims and specification of the '436 Patent.

33. The '436 Patent generally describes systems and methods for determining roof measurement information based on aerial images of a roof of a building. *See, e.g.*, '436 Patent, 1:16-20; 3:51-56.

34. FIG. 8 of the '436 Patent, in particular, discloses steps for performing a roof estimation for a building. According to FIG. 8 of the '436 Patent, the steps include receiving a first and a second aerial image of a building (each of the aerial images providing a different view of the roof of the building), correlating the first aerial image with the second aerial image, generating (based at least in part on the correlation between the first and the second aerial images) a three-dimensional model of the roof, and preparing and transmitting a roof estimate report that includes one or more annotated, top-down views of the three dimensional model. *See, e.g.*, '436 Patent, FIG. 8.

35. I understand the '436 Patent to disclose that the first and second aerial images could be different images of the same building, taken from different perspectives. Claim 1 of the '436 Patent specifies that the first aerial image is a “top plan view” of the roof and the second aerial image is an “oblique perspective view” of the roof.

36. A person of ordinary skill in the art would understand the term “top plan view” to mean a view of an object (such as a building) that is taken vertically or nearly vertically above the object, and looking down on the object.

37. Furthermore, a person of ordinary skill in the art would understand the term “oblique perspective view” to mean a view of an object (such as a building) that is taken from a position (perspective) that is neither vertically nor nearly vertically above the object. For example, a view of an object taken at an angle of 45 degrees to the object would be an oblique perspective view. Of course, other angles are possible for a view of an object to be an oblique perspective view, so long as the view of the object is not taken vertically or nearly vertically above the object.

38. I also understand that the ‘436 Patent claims, including Claim 1, state that the first and the second aerial images are not a “stereoscopic pair.”

39. A person of ordinary skill in the art would understand “stereoscopic pair” to mean a pair of images that are taken in such a way as to give the appearance of depth (e.g., when the images are viewed with a device such as a stereoscope that ensures that each eye sees only one image of the pair respectively). A stereoscopic pair of images is two images that: (a) are taken in the same general direction toward an object, (b) from two different points in space that

have the approximate same distance from that object, and (c) that create an impression of depth when viewed together.

40. Two photographs, to be stereoscopic, need to have a separation in space, in a similar fashion that human eyes are separated. It is immaterial whether they are taken at different times (e.g. from a moving airplane), or at the same time (e.g., two cameras activated at the same time).

41. Given this understanding of the term “stereoscopic pair,” it is my opinion that a person of ordinary skill in the art would understand the term “not a stereoscopic pair” to mean two images of the same object that do not give the appearance of depth when viewed together. In light of this understanding, it is my opinion that one image of a building taken from vertically or nearly vertically above the building (a “top plan view”) and another image of the same building taken from a position that is neither vertically nor nearly vertically above the building (an “oblique perspective view”), and which, when viewed together, do not give the appearance of depth, would not be a stereoscopic pair of images.

## **VI. The References Cited By the Petition**

42. I have carefully reviewed certain references in view of the claims of the ‘436 Patent, as discussed below. I have been informed by counsel that in understanding the meaning of the claims, I am to apply the broadest reasonable interpretation in view of the specification. I have further been informed that, while



the standard of “claim construction” is not pertinent in understanding what the references actually teach, I have in mind the claim construction standard in providing my comments below concerning the relationship of the references to the claims of the ‘436 Patent.

43. I understand a person of ordinary skill in the art to be someone with a bachelor’s degree in photogrammetry, surveying, or civil engineering or an equivalent educational background, or having many years’ worth of pertinent experience that is recognized by the American Society of Photogrammetry and Remote Sensing, as established through peer review and certification.

## **VII. The Hsieh Publication**

44. Hsieh discloses a semiautomatic system for generating models of buildings using multiple aerial images.

45. Hsieh discloses processing multiple aerial images that are not stereoscopic pairs, including top-down plan views as well as oblique perspective views of the same building. *See, e.g., Hsieh*, FIGS. 1 and 18. Such top-down and oblique perspective views are not stereoscopic pairs because, when viewed together, they do not give the impression of depth.

46. In particular, Hsieh discloses an automated and semi-automated site modeling system that can model roofs having a plurality of planar roof sections using one or more aerial images. *See, e.g., Hsieh*, Abstract. The system is a

computer-based, photogrammetric system whereby building features are identified in two or more aerial images, and the identified features are processed using photogrammetric techniques to create a three-dimensional model of the building, including the roof of the building.

47. The system of Hsieh can generate peak roof building models, which require at least two roof planes. *See, e.g., Hsieh*, p. 6.

48. To model roofs in Hsieh, the user measures the roof of a building in one aerial image by outlining the roof in that aerial image. The system then detects peaks, edges, and other roof features in the image, and generates a full three-dimensional (3D) model of the building (including the roof). The system also projects the 3D model onto other aerial images of the building. *See, e.g., Hsieh*, pp. 6-7. The projection of the 3D model on the other images can occur as line drawings. *See, e.g., Hsieh*, p. 10.

49. In Hsieh, the building measurement process is broken down into a verification component, an object matching component, and an edge estimation component. *See, e.g., Hsieh*, p. 10. The verification component verifies the existence of an object in an image. *See, e.g., Hsieh*, p. 10. The object matching component generates a set of hypotheses for the location of the object in the image. *See, e.g., Hsieh*, p. 10. The edge estimation component generates a set of possible edge hypotheses for the model. *See, e.g., Hsieh*, p. 10. Multi-image roof matching

could be used to generate a set of roof hypotheses by triangulating building hypotheses from at least two images. *See, e.g.,* p. 20.

50. Hsieh discloses using an automated process to determine the height of the building and to correct the location of the building in other images (related to multi-image matching processes). *See, e.g.,* Hsieh, pp. 6-7. Further, Hsieh discloses achieving accurate three-dimensional measurements by locating a projected object in several images. *See, e.g.,* Hsieh, p. 16.

51. After processing by the system is complete, Hsieh generates a digital, three-dimensional, computer-based model of a building, with associated measurements. It is my opinion that, at the time of filing of the '436 Patent, it was well within the knowledge of one of ordinary skill in the art to generate a roof estimate report using the models generated by Hsieh. For example, Hsieh discloses calculating actual building measurements for the model (e.g., in meters). *See, e.g.,* Hsieh, p. 19 (describing automated processes for building measurements). It would be very simple for one of ordinary skill in the art to modify the output of Hsieh so that such measurements are displayed next to the modeled building features, thereby generating an annotated roof estimate report. Moreover, it is my opinion that one of ordinary skill in the art understands that an annotated model could be viewed from various perspectives (e.g., a top plan view of the model could easily be shown).

52. Additionally, since the system of Hsieh generates a digital model, it is also my opinion that one of ordinary skill in the art would have appreciated at the time of filing of the '436 Patent that such a model could easily be exported for use in another program to generate a roof estimate report. One example of such a software package is the system disclosed in the Applicad manual, which I discuss below.

### **VIII. The Applicad Manual**

53. The Applicad manual discloses a system for generating three-dimensional roof models and reports thereof. *See, e.g., Applicad*, Cover Page. The system disclosed in Applicad is a computer aided design (CAD) system that can be used to draw various building features, such as roofs of buildings.

54. The system of Applicad allows a user to generate and modify a three-dimensional roof model, including changing the pitch of roof planes. *See, e.g., Applicad*, p. 7-14. The software automatically updates areas and lengths as new features are inserted and/or modified. *See, e.g., Applicad*, p. 13.

55. From the 3D drawing created in Applicad, the software automatically calculates the necessary roofing material to generate a detailed quote. *See, e.g., Applicad*, p. 2. Further, users can generate user-defined forms (e.g., custom forms) which include quotations and drawings, and extract desired information. *See, e.g., Applicad*, pp. 2, 39-40, 42. Accordingly, the system of Applicad can generate a

roof estimate report, including a top plan view of a three-dimensional model that is annotated with measurement information of the roof (e.g., roof pitch, etc.), among various other types of information. *See, e.g., Applicad, p. 40.*

56. It is my opinion that one of ordinary skill in the art at the time of filing of the '436 Patent could easily have incorporated the roof estimate report features of Applicad, including annotated roof measurements, into a system such as Hsieh which generates three-dimensional models of building roofs from aerial imagery. Doing so would involve merely modifying the system of Hsieh so that it displays roof measurement information (e.g., lengths of roof features, areas, pitches, etc.) next to the 3D model generated by Hsieh so as to provide a roof estimate report. Indeed, as I mentioned above, the system of Hsieh already makes measurements of a modeled building, and it would be a simple matter to annotate such a model (or to show it in a top-plan view).

57. Further, the Applicad system can also import a model generated in another computer program, in the form of a roof or wall outline in three dimensions. *See, e.g., Applicad, pp. 2, 4.* Roof models can be imported using various file formats (e.g., drawing exchange format (.dxf)) or from a scanned image or bitmap. *See, e.g., Applicad, pp. 4, 6.*

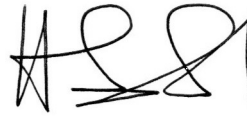
58. It is also my opinion that one of ordinary skill in the art would appreciate that the system of Applicad could take as input the three-dimensional

building model generated by Hsieh, and generate a roof estimate report using the model. As noted above, Applicad expressly discloses that the system includes the ability to import building outlines (models) from other software packages, and as such, one of ordinary skill in the art could import the Hsieh model into the Applicad system using the import feature.

59. It is my opinion that one of ordinary skill in the art, at the time of filing of the '436 Patent, would have appreciated the benefits of annotating the model generated by Hsieh in the manner done by Applicad. For example, by annotating the model of Hsieh with measurement data, there would be easy and effective communication of roof measurement results to the user. Indeed, the roof measurement data is already in the model generated by Hsieh, and one of ordinary skill in the art would have found it useful to see such data displayed next to the model in Hsieh.

*I hereby certify that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true, and further certify that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.*

Executed on: February 5, 2016

A handwritten signature in black ink, appearing to read 'H. Schuch', written over a horizontal line.

Harold Schuch

# **ATTACHMENT A**



# Full Curriculum Vitae of Harold C. Schuch PE, LSI, Certified Photogrammetrist

Version 2015/10/30

## Detailed Experience

### GeoCounsel, Inc., Littleton, Colorado, USA.

Mr. Schuch started his activities as consultant in March of 1993, when he founded GeoCounsel, Inc., a registered corporation in the State of Colorado. GeoCounsel provides a variety of services, with an emphasis on projects that have a mix of Geomatics, Geographic Information System (GIS), engineering, surveying, mapping, and photogrammetry components. It offers implementation consulting in a national and international context, including the preparation of documents such as requests for proposal (RFPs) and contracts. As of now, it has completed over 150 projects in 16 countries using 6 languages. The following is a sampling of the consulting services Mr. Schuch has performed so far (starting with the most recent):

- **Metz.** In 2015, Mr. Schuch was appointed drainage engineer for a property in Denver. He prepared a Phase III Drainage Report and plan. This involved aerial imagery analysis, mapping, site re-grading design, and site drainage design.
- **Cohen.** In 2015, Mr. Schuch was retained as expert witness for a land dispute. This involved aerial photo interpretation, documentation of ground evidence, photogrammetric mapping, and report preparation.
- **City of Aspen, Colorado.** In 2015, Mr. Schuch was asked to perform aerial photo interpretation for an area in dispute within that city, resulting in a report that was used to successfully suit the needs of the city.
- **Various unnamed activities.** In 2014 and 2015, Mr. Schuch undertook various activities for customers, who cannot be divulged as per contract.
- **Cage.** In 2013, Mr. Schuch was asked to provide Expert Witness assistance to a farm drainage dispute in Weld County, Colorado.
- **Unnamed as per NDA.** In 2013, Mr. Schuch assisted a large regional group of government agencies (with 60 agencies participating) with the development of comprehensive Technical Terms of Reference for aerial Digital Imagery and LiDAR data acquisition.
- **Commerce City.** In 2013, Mr. Schuch helped the GIS Department of this Colorado city with technical issues related to datums and the building of a parcel database.
- **Unnamed as per NDA.** In 2013, Mr. Schuch collected terrestrial photogrammetric data and performed rigorous block adjustments toward a research project involving automated video mapping data.
- **Unnamed as per NDA.** In 2012, Mr. Schuch helped the owners of significant portions of land over the Bakken oil and gas deposit in North Dakota with the development of a comprehensive dossier on their holdings, including land, transportation, farming, deposits, wells, gathering lines, setback agreements, development plans, etc., in a GIS and multi-media format.
- **Metz Architects.** In 2013, Mr. Schuch developed an engineering hydrology design for a large property in Colorado (subjected to the scrutiny of, and approved by, the City of Denver Utilities Department – “Denver Water”).
- **Xcel Energy.** In 2012, Mr. Schuch helped this company with GIS data validation activities related to its extensive facilities GIS database, in support of its Integrity Management efforts regulators demand. This included the identification of High Consequence Areas (HCA) along several regional transmission pipelines.

- **Varra.** In 2012, Mr. Schuch provided a precise volume calculation of the largest sand stock pile in the Rocky Mountain Region, using terrestrial photogrammetric methods with calibrated cameras.
- **Stellacore.** In 2011, Mr. Schuch helped develop a review of geodetic concepts, such as “dynamic heights”, for this photogrammetric company.
- **Geodesy Course.** In 2011, Mr. Schuch started giving regularly scheduled short courses in Geodesy for GIS, GPS, mapping and surveying technicians with the purpose of increasing professional judgment.
- **Kyrgyzstan.** In 2011, Mr. Schuch provided marked-up imagery for parties in Germany and Kyrgyzstan.
- **Dinosaur Ridge.** In 2011, Mr. Schuch prepared a close-range photogrammetric ortho image of this dinosaur fossil bed in Morrison Colorado, plus contour maps for engineering planning purposes, as published in two magazines (“Side Shots” of the Professional Land Surveyors of Colorado and “PE&RS” of the American Society for Photogrammetry and Remote Sensing).
- **The World Bank.** In 2011, Mr. Schuch was asked to act as consulting arbiter in relation to a project in Argentina that required the knowledge of international mapping and GIS technologies.
- **Integrity Solutions, Inc.** In 2010, GeoCounsel, Inc. was asked by this company (“IS”) to assume the role of Exclusive International Reseller of its integrity management products and services.
- **Stellacore.** In 2010, Mr. Schuch was asked to help manage a software development program that dealt with very advanced multi-discipline photogrammetric technologies. This included the design and production of a state-of-the-art camera calibration target.
- **The World Bank.** In 2010, Mr. Schuch was asked to review several technical proposals toward a cadastral system in Argentina, and the bidder evaluation methods of a Bank customer. This included a review of scoring methods, and the development of opinions in relation to detailed technical issues.
- **Loukonen.** In 2010, Mr. Schuch was asked to act as an Expert Witness for a court case involving adverse possession of lands in Boulder County. The work included the analysis of zoning, aerial photography, satellite imagery, fences, drainage, and survey maps.
- **St. Jude’s.** In 2009 and 2010, Mr. Schuch was asked to act as an Expert Witness for a court case involving adverse possession in Pitkin County. The work included the utilization of digital aerial and satellite image interpretation, zoning review, and hydrology (FEMA).
- **Tri-Power.** In 2009 and 2010, Mr. Schuch’s services were retained by this renewable energy company in Colorado for the engineering design of micro-hydro electrical power plants and the related pre-installation engineering inspections and opinions.
- **Stellacore.** In 2009 and 2010, Mr. Schuch was asked to assist with the management of a software development program dealing with very advanced and highly automated photogrammetric toolsets.
- **The World Bank.** In 2009, Mr. Schuch was asked by that bank to review various documents, such as Requests for Proposals, issued by seven Argentinean provinces for the acquisition of large regional server-based IT and/or GIS-based systems (for tax mapping and property registration system renovations).
- **Stellacore.** In 2009, Mr. Schuch performed, for this advanced software developer, research activities to establish European and Asian use of geodetic datums in aerial and satellite

mapping activities. This work is in support of software to be used by satellite companies and users of digital aerial cameras.

- **City of Ketchikan.** In 2008, Mr. Schuch was asked by this city in Alaska to act as assistant Project Manager and Quality Control representative during their regional photogrammetric ortho-rectification project for their GIS used by the Department of Public Works. This project covered several hundred square miles.
- **Woolpert.** In 2008, Mr. Schuch was asked by Woolpert, a Colorado Engineering, Surveying, and Photogrammetry firm, to give a course in Geodesy to its technical staff.
- **Government of Taiwan.** In 2008, Mr. Schuch was appointed by the Government of Taiwan to provide a comprehensive, one-week-long review of Emergency Response GIS to Taiwan government employees and staff of various universities. This work was sponsored by GeoEye, the largest satellite imagery company in the world.
- **City of Grand Junction.** In 2008, Mr. Schuch gave a course in Geodesy to the staff of the GIS Departments of the City of Grand Junction and Mesa County, Colorado
- **US Department of Justice.** In 2007, Mr. Schuch performed aerial photo interpretation services for a case involving this large Washington, D.C. agency.
- **MapTrailer.** In 2007, Mr. Schuch designed and implemented a comprehensive mobile Emergency Response GIS/mapping solution for the National Map Research, to serve the mapping and communications needs of several Fire Departments and Incident Commanders in remote regions in the Western USA.
- **City of Pueblo.** In 2007, Mr. Schuch gave a course in Geodesy to 23 students in the region of Pueblo, Colorado.
- **SolarDemocracy.** In 2007, Mr. Schuch was retained by this algae research group to build a GIS database of all the watersheds of Colorado for the purpose of collecting algae samples.
- **Carter-Burgess.** In 2007, Mr. Schuch was retained by Carter-Burgess, one of the largest civil engineering companies in Colorado, to provide geodesy, photogrammetry, GPS and GIS training for a group of its staff.
- **Iraq.** In 2006, Mr. Schuch was retained by American University of Washington, D.C. to assist with a community development project in Iraq. Mr. Schuch designed the mapping and GIS/GPS infrastructure for a census project, acted as Master Trainer for the project including 200 census takers, and helped manage large-scale field operations. This work involved five trips of three to five weeks stay each in Iraq.
- **Tri-State.** In 2005, Mr. Schuch was retained by Har\*GIS LLC to assist with the implementation of a GIS-based Field Force Automation system by providing Tri-State personnel training in GPS fundamentals. Tri-State Generation and Transmission Association, Inc. is a nonprofit, wholesale power supply cooperative that provides electricity to 44 member distribution systems serving major parts of Colorado, Nebraska, New Mexico and Wyoming.
- **NREL.** In 2005, Mr. Schuch was retained by the National Renewable Energy Laboratory (part of the US Department of Energy) for the purposes of developing the formulae for a calculation of the micro-hydro potential for the whole country of Sri Lanka. These formulae were then used to build a potential map in GIS.
- **Har\*GIS.** In 2004, Mr. Schuch provided consulting and project implementation services to har\*GIS clients. Har\*GIS provides hand-held field automation and GIS/GPS solutions to utilities and others. These solutions are normally integrated with in-house GIS and DBMS.

- **Leica.** In 2003, Mr. Schuch provided 14 Leica staff with a comprehensive 1-week, full-time introductory course to Photogrammetry, Geodesy, GIS and GPS.
- **Resource21.** In 2003, Mr. Schuch was retained by this satellite image processing company to review the accuracy of satellite image products and the corresponding digital image production workflow.
- **ITT Industries, Systems Division.** In 2003, 2004, and 2005, this large U.S. Government Contractor retained Mr. Schuch to provide GIS know-how to the U.S. Federal Highway Administration. The work consisted of designing the GIS component for a comprehensive computerized accident countermeasure program for the US highway system.
- **NREL.** In 2003, Mr. Schuch was retained by the National Renewable Energy Laboratory (part of the U.S. Department of Energy) to develop a Site Development Plan for future expansion.
- **Resource21.** In 2002, Mr. Schuch was retained by this satellite image processing company to develop process workflows for various digital products derived from satellite images.
- **Pixxures.** In 2002, Mr. Schuch was retained by this image processing company under a 6-month contract to assist with various mapping, digital photogrammetry, and GIS international marketing activities.
- **Pixxures.** In 2001, Mr. Schuch was retained by this image processing company to analyze its production line in digital photogrammetry from the point of view of productivity. This work was completed, resulting in a comprehensive review document containing a long list of recommendations.
- **COMGAS.** In 2001, Mr. Schuch provided continued GIS and database implementation support on the basis of regular visits to this Brazilian gas company (see COMGAS below).
- **DigitalGlobe.** In 2000, Mr. Schuch provided this satellite company with a technical review of their in-house satellite image production workflow, including a productivity analysis thereof.
- **DigitalGlobe.** In 2000, Mr. Schuch provided this satellite company with a comprehensive photogrammetric consulting effort toward the outsourcing of certain production aspects. This included the development of an implementation plan, several agreements regarding data, business handling, and software, and the selection of potential co-producers, national and foreign.
- **DigitalGlobe.** In 2000, Mr. Schuch gave a "Course in Photogrammetry" to two dozen employees of this satellite company. This course lasted for half a year and consisted of 22 class sessions and laboratories, with field trips. The course material contained all the important concepts in mapping, including geodesy, GPS, control, adjustment, photogrammetric production, quality control, and historic and market backgrounds.
- **COMGAS.** In 2000, Mr. Schuch assisted this largest Brazilian gas company in São Paulo during the acquisition of a comprehensive GIS solution. The work included a needs assessment, a cost-benefit study (gaining budget approval in the process), the development of technical specifications, and assistance during vendor selection and contracting. This included the development of a comprehensive data conversion strategy, the development of technical specifications and the selection of system and database providers.
- **Georgia LRU.** In 2000, Mr. Schuch assisted the Land Records Unit of this former Soviet republic with aerial flight vendor bid evaluation. Also, Mr. Schuch provided 6 staff members of the LRU with instruction on how to perform quality control of delivered photography, how to accept/reject deliveries, and how to organize an in-house data quality control program.

- **COMGAS.** In 1999, Mr. Schuch provided a GIS workshop for this important gas company serving São Paulo. The topic of this workshop was "GIS project management and timeline development".
- **EPM.** In 1999, Mr. Schuch provided a one-week workshop for this very large Colombian utility company (Empresas Públicas de Medellín). The topic of the workshop was "taking a GIS in development into production". Having developed a large GIS solution, the Information Systems Group of EPM was rolling the system out for all the users, which number in the hundreds.
- **Argentina Ministry of the Interior.** In 1999, Mr. Schuch assumed the role of prime GIS / Cadastral System consultant for all of the 19 Argentinean provinces embarked in cadastral programs, a World Bank project. The work involves the complete range of oversight activities, covering project planning, data conversion, system implementation and user productivity.
- **City of Northglenn.** In 1999, Mr. Schuch provided project-planning services to this city in Colorado, USA, toward the implementation of a citywide comprehensive GIS implementation. The work included a Needs Assessment, a Conceptual Design, and a Cost-Benefit Study.
- **Georgia LRU.** In 1999, Mr. Schuch developed a tender document for an AGPS-based photogrammetric flight for the Land Registration Unit of the Georgian government in Tbilisi, Georgia. This tender document was prepared under World Bank International Competitive Bid (ICB) guidelines.
- **ASI.** In 1999, Mr. Schuch provided a marketing workshop to Analytical Surveys, Inc., (now Sanborn Mapping) in Indianapolis. A group of the top corporate managers attended. ASI is the largest GIS data conversion company in the world.
- **Luz Del Sur.** In 1998, Mr. Schuch provided GIS project start-up consulting to this Peruvian power company. The work included initial project formulation, project plan development, and personnel training in GIS concepts and implementation management.
- **The World Bank.** In 1998, Mr. Schuch joined 2 official 2-week missions of the World Bank to Argentina. His responsibility was to evaluate the progress of GIS-based cadastral system implementations in 19 different provinces. This work included the review of aerial mapping and general GIS implementation RFPs. These missions were repeated in 1999.
- **CELESC.** In 1998, Centrais Elétricas de Santa Catarina (CELESC), Brazil retained Mr. Schuch to assist in the preparation of the technical terms of reference components for this important power generation and distribution company, including aerial mapping and field inventory RFPs.
- **BUENOS AIRES.** In 1998, Mr. Schuch was retained by the Province of Buenos Aires to participate in talks with the Inter-American Development Bank in Washington, D.C., to discuss the Province's cadastral system implementation.
- **CELESC.** In 1997, Mr. Schuch prepared a GIS Implementation Plan for CELESC. This is the state-owned electrical power company. This plan is used to manage the implementation of GIS for the 16 regional offices of CELESC throughout the State of Santa Catarina.
- **CELESC.** In 1997, Mr. Schuch wrote terms of reference towards the purchase of electrical power data conversion services for Centrais Elétricas de Santa Catarina (Brazil), a Systemhouse/VISION-based project.
- **CELESC.** In 1997, Mr. Schuch wrote terms of reference towards the purchase of aerial mapping for Centrais Elétricas de Santa Catarina (Brazil), a joint project between CELESC, the Municipality of Florianópolis, and CASAN, the local water company. The RFP was designed in such a way that it was clear that the data had to be utilized in a GIS.



- **The World Bank.** In 1997, Mr. Schuch joined 2 official 2-week missions of the World Bank to Argentina. His responsibility was to evaluate the progress of GIS-based catastral system implementations in 19 different provinces.
- **EPM.** Empresas Públicas de Medellín, the largest South-American utility with an over \$2 Billion yearly budget, hired Mr. Schuch in 1997 to provide GIS consulting toward data conversion for their SIGMA GIS.
- **GIS BRASIL '97.** In 1996, Mr. Schuch was asked to give an 8-hour course (3 mornings) in GIS management during this conference, the largest GIS conference in the world (5,000 attendees). Mr. Schuch is part of the technical committee of the conference and contributes magazine articles to "Fator GIS".
- **BUENOS AIRES.** In 1996, Mr. Schuch prepared a Needs Assessment, a Conceptual Design, and a Cost Study with an Implementation Plan for a Cadastral System for the whole of the Province of Buenos Aires. This involves over 6 Million parcels and it is World Bank funded. This work was done for the Dirección de Catastro of the Ministerio de Economía in La Plata.
- **COBRAC.** The "Congresso Brasileiro de Cadastro Técnico Multifinalitário" (COBRAC) is Brazil's only conference on multipurpose cadastres. The Universidad de Santa Catarina in Florianópolis organizes it. Mr. Schuch was invited by the university to give a 12-hour course on GIS implementation and management entitled "Geoprocessamento Comum a todas Concessionárias de Serviços Públicos e Prefeituras" (Geoprocessing common to all the utility companies and municipalities).
- **TELESP.** In 1996, this telephone company in São Paulo, Brazil, was embarking on a very large, country-wide GIS implementation. They serve about 40% of all telephones in Brazil. Presently they have about 5 Million customers and expect to connect 1.5 Million phones in the next 2 years. Mr. Schuch provided a three-day GIS implementation management seminar to about one dozen TELESP representatives, covering with them the special data conversion program that was developed by TELEBRAS, the Brazilian telephone industry central office.
- **CONSTRUTEL.** This engineering company in Belo Horizonte, Brazil, is the representative of SystemHouse of Ottawa, Canada, selling the VISION software. In 1996, Mr. Schuch was retained to provide a one-week (40 hour) GIS technology and marketing course for seven members of CONSTRUTEL's staff to help them become more effective during GIS sales and implementation.
- **CELESC.** In 1996, Mr. Schuch provided project assistance to this Brazilian electric power transmission and distribution company. Having about 1.3 Million customers and covering the whole state of Santa Catarina, CELESC is implementing a GIS based on SystemHouse's VISION software. Mr. Schuch provided initial project audit activities, project organization seminars, and electric system modeling reviews. Also, Mr. Schuch established event calendars for system component deliverables to account for sensitive dependencies between them.
- **DigitalGlobe.** In 1996, Mr. Schuch was retained by this satellite imaging company in Longmont, Colorado, to develop, in a consortium with two other companies, photogrammetric guidelines for satellite images in preparation for their high-resolution satellite launch.
- **The World Bank.** In 1995, Mr. Schuch participated in a two-week World Bank mission to Argentina to assess the progress of the cadastral projects that are underway in the different provinces of that country. This work included several assessment and technical audit activities. In 1996, Mr. Schuch participated in a three-week mission with the bank to Argentina to continue evaluating Argentina's cadastral projects and to provide on-site assistance as needed to streamline GIS technology implementation.

- **Sui Northern Gas Pipelines**, Lahore, Pakistan. In 1994, A World Bank-supported gas distribution company in the process of being privatized, Sui Northern (SNGPL) needed to develop its gas network planning capabilities and required the preparation of a Network Analysis system implementation plan. Mr. Schuch wrote a Needs Assessment Report, a Strategic Implementation Plan, and a Cost-Benefit Study for Network Analysis. The Final Presentation about this work was very successful, causing top management to decide to proceed with implementation of this technology as planned - coming to this conclusion within 24 hours of that presentation. The planned solution needed to be based on technologies, procedures and methodologies that were demonstrably sustainable within the political and work environment of Pakistan. This work, which took two months on location in Lahore and Islamabad, also included a look at SNGPL's overall software technology needs.
- **State of Santa Catarina**, Brazil. In 1993, Mr. Schuch developed a "Plano Diretor de Geoprocessamento do Estado de Santa Catarina" (Geoprocessing Master Plan for the State, also called "PDG/SC") which included creating a vision and a conceptual design for all the potential GIS users for that State. This involved bringing together 12 State departments with 143 user groups (including roads, electricity, water, environment, police, governor's office, agriculture, geology and mining, regional planning, hydrology, state administration, etc.). The plan was designed so that the overall GIS structure included the following aspects: corporate issues, financial issues, administrative issues, system design (hardware/software/communications), application design, data conversion plan (including accuracies and aerial mapping/digitizing), user issues (support, etc.). This work, which took 7 months to complete, consisted of a comprehensive user requirements study (Análise de Necessidades), the plan itself (PDG/SC) and a cost-benefit study (Análise de Custo-Benefício). This work satisfied the customer (the governor-appointed Comissão de Geoprocessamento de Santa Catarina or CGEO/SC) and only with time it sunk in that never before a GIS planning project of this magnitude was undertaken in South America. On September 21, 1994, Mr. Schuch delivered the project to the Governor and his complete cabinet during a final presentation that was very well received. As a result, the Governor said that he will pass legislation that will cause this plan (the PDG/SC) to be officially adopted.
- **Tangent Color Systems**, Colorado, USA. In 1993, Mr. Schuch was asked to prepare a white paper to position large industrial scanning systems, manufactured by Tangent Color Systems, within the Geographic Information Systems marketplace.
- **Integrated Water Technologies**, California, USA. In 1993, Mr. Schuch was asked to identify three-dimensional Geographic System offerings available in the marketplace that are suitable for underground water resources tracking and management. System products were identified and recommended. IWT's GIS database and 3D display capabilities have become a valuable tool for watershed modeling.

## Prior Employment History

This is presented in reverse chronological order.

- **UGC Consulting**, Englewood, Colorado, USA. A Senior Technical Consultant and Executive Consultant for UGC Consulting for about five years, Mr. Schuch actively handled AM/FM, GIS, network analysis, and work management projects for utility companies, cities, and counties for this company. He completed Feasibility Studies, Cost-Benefit Studies, Strategic Implementation Plans, and data conversion designs for dozens of projects. Mr. Schuch acted as consultant to various important data conversion companies, such as Geonex, Baymont, MSE, ASI, Intera and QC Data. He also developed a 10-year GIS marketing plan for IBM.
- **Wild Heerbrugg Systems**, Toronto, Ontario, Canada. Before joining UGC Consulting, Mr. Schuch held the position of Market Center Manager for the System 9 GIS product for the whole



of Canada for two years, while this product was being developed by Wild in Toronto. Among his responsibilities were the identification of sales opportunities, the supervision of all system support functions, the identification and documentation of general market requirements, and the supervision of the development of all the support documentation for the system.

- **HASP, Inc.**, Loveland, Colorado, USA. Prior to his experience with Wild Heerbrugg Systems, Mr. Schuch was Vice President of HASP, Inc., for 8 years. There he was responsible for the development and distribution of the HASP Photogrammetric System. This included the development of all system code, the design and implementation of mathematical solutions, object code, documentation, sales, customer support, international activities such as system export, and program administration, including invoicing, tracking, and collections. He also developed special applications software such as photogrammetric volume calculations, hydrologic software development (e.g. urban runoff calculations) and interactive COGO.



He also developed the HASP Cadastral System, which constitutes one of the first digital cadastral GIS implementations in the world. In 1985 he received the Governor's Award for Excellence in Exporting for this (see photo).

- **Marshall, Macklin, Monaghan, Ltd.**, Toronto, Canada. Once he completed his Master's program at the University of Washington, Mr. Schuch accepted a position as Assistant Manager for this engineering firm's Photogrammetric Section for two years. He was responsible for production (plotters, scribing, and reproduction), technical guidance, quality control, problem resolution, and customer service. This included project planning, management, and design.

## Some Articles and Publications

- **"The Photogrammetry of UAVs"**, 1-hour presentation during the 2015 GIS In The Rockies Conference, Denver, Colorado.
- **"Geodesy, that pesky discipline"**, 1-hour presentation during American Oil and Gas Surveyors' Association, 2015 Annual Meeting, West Chapter.
- **"GIS and Business"**, article published in the July 2014 issue of Side Shots, the official magazine for the Professional Land Surveyors Association of Colorado.
- **"Flat Earth Thinking Removed"**, highlight article published in the November 2012 issue of PE&RS, the official magazine of the American Society for Photogrammetry and Remote Sensing.
- **"Introduction to Geodesy"**, 2-hour presentation during the 2013 Annual Professional Land Surveyors of Colorado Conference.
- **"GPS Accuracy"**, Presentation during the 2012 GIS in the Rockies Conference.
- **"GPS Accuracy"**, 42-page technical paper dealing with all aspects of GPS accuracy. This is a peer-reviewed article that was read and approved by GPS experts recognized as such by NOAA and NGS.
- **"Dinosaur Ridge, Morrison, Colorado"**, article on close range photogrammetry applied to this dinosaur footprint site, published in PE&RS, the official publication by ASPRS, Virginia.
- **"Theodolites vs. Cameras"**, article on close range photogrammetry applied to Dinosaur Ridge, Morrison, Colorado, published by Side Shots, the official publication by the Professional Land Surveyors of Colorado.
- **"Geodesy Revisited"**, three hour presentation made, 2009 Fall Technical Session, Professional Land Surveyors of Colorado, Denver, November 2009.
- **"Geodesy for GIS"**, two-day course given during the Annual South-West ESRI User Group Conference in Pueblo, Colorado, August 2009.
- **"Geodesy"**, presentation during Colorado Height Modification Conference, Grand Junction City Hall, Grand Junction, Colorado, April 2009.
- **"Geodesy"**, presentation during Colorado Height Modification Conference, Colorado Department of Highways, Denver, Colorado, April 2009.
- **"Geodesy for GIS"**, taught this three-month, Winter Quarter 2009 course for University College, Master's Degree Program, Denver University.
- **"Is the Earth flat?"**, paper dealing with the problems of using various mismatching ground control systems in the American Congress of Surveying and Mapping (ACSM) Bulletin, Issue 235, October 2008.
- **"Emergency Response GIS"**, 3-day course given to National Technical University Taipei, Taiwan, April 2008.
- **"GIS and Technology Adoption Cycles"**, V1 Magazine article, web-based at <http://vector1media.com/>, April 2008.
- **"Potentials of Remote Sensing & GIS for National Demographic Survey and Census Enumeration"**, Presentation during Satellite Remote Sensing (NigeriaSat-1) and GIS: A Solution to Sustainable National Development Challenges Workshop, organized by NATIONAL SPACE RESEARCH AND DEVELOPMENT AGENCY, Abuja, Nigeria, June 2004.

- **"Como implantar um GIS com sucesso"**, interview in the new Brazilian geoprocessing portal MundoGEO. September 2001.
- **"GIS para catastros municipais"**, paper during the Brazilian GIS conference GEOBrazil 2001. June 2001. Also discussion panel moderator for "Implantação de GIS".
- **Accuracy in Geomatics**, Author of book in the process to be published.
- **"Buy and Sell GIS Differently"**, GEOWorld, February 1999.
- **"GIS e Planejamento Urbano"**. Course of 12 hours for attendees of COBRAC III Conference covering municipal and cadastral geoprocessing. Florianópolis, Brazil. October 1998.
- **"GIS Dat Conversion"**, Course of 3 hours during A/E/C Systems Conference, Philadelphia, USA. June 1997.
- **"Geoprocessamento: Ferramenta Comum a Prefeituras e Concessionarias"**, Twelve-hour course for attendees of COBRAC II Conference, Florianópolis, Brazil. October 1996.
- **"Brazil Leads the Way"**, ARC News. USA, Vol. 18 No. 1.
- **"Riscos na Conversão de Dados."** Fator GIS. São Paulo, Brazil, December 1994.
- **"Desenvolvimento de GIS para Multiusuários, Dificuldades e Riscos"**, GIS Brasil '94 Conference. Curitiba, Brazil. October 1994.
- **"Cadastro e GIS"**, 1º Congresso Brasileiro de Cadastro Multifinalitário. Florianópolis, Brazil. August 1994.
- **"Data Conversion Management Issues."** 5th GIS in the Rockies Conference. Golden, Colorado. September 1993.
- **"Project Management: From Maps to Digital Files."** International Association of Assessing Officers (IAAO). 59th Annual Conference on Assessment Administration. Mapping Seminar. Washington, D.C.. September 1993.
- **GIS Data Conversion Handbook**. Co-author. *GIS World* publication, 1993.
- **"Los AM/FM/GIS en Aplicaciones de Redes."** Instructed a one-day course on GIS and utilities. AESIG Conference. Madrid, Spain. June 1993.
- **"GIS Issues, Benefits, and Risks."** The World Bank and the Inter-American Development Bank. Washington, D.C. March 1992.
- **"Technology Drives Future of Conversion Services."** Co-author with Glenn E. Montgomery. *GIS World*, November 1991.
- **"Spatial Information Solutions for the Next Decade."** Canadian Institute of Surveying and Mapping. Edmonton, Canada. May 1991.
- **"CAD/GIS Market."** Barbados Export Promotion Corporation. Export Business Development Conference. Barbados. May 1991.
- **"GIS and People."** Western Association of Highways and Transportation Officials Conference. Beaver Creek, Colorado. August 1990.
- **"AM/FM and APWA."** APWA Reporter. American Public Works Association. March 1990.
- **"Wild System 9 Database Structure."** Baltimore, Maryland. March 1987.
- **"Sistema Interactivo para Levantamientos Catastrales."** Mexico City. May 1985.

- **"Computer-assisted photogrammetric mapping system for geologic studies-a progress report", USGS**, Pillmore, C. L., K. S. Dueholm, H. S. Jepsen, and C. H. Schuch, 1981, Photogrammetria, v. 36, p. 159-171.
- **"Photogrammetric Determination of Motions and Rotations Within the Living Human Body"** ASPRS Conference. Seattle, Washington. March 1976.

## **Recent Symposia & Workshops participated in**

**GIS In The Rockies** – Denver, September 2015

- Track Chair for Photogrammetry
- Conference Liaison for ASPRS
- Conference Organizing Committee Board Member

**SPAR** – Colorado Springs, June 2014

**CSRN** - Colorado Spatial Reference Network – frequent board meetings, Aurora, Colorado

**October 2011** - Annual Geoid Monitoring Committee Meeting  
NOAA/Boulder, Colorado

**October 15, 2009** - Workshop on Long-Term Monitoring of Geoid Change  
CGU/CMOS Meeting, Ottawa, ON

**...Plus many other symposia and meetings.**