

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

XACTWARE SOLUTIONS, INC.
Petitioner

v.

EAGLE VIEW TECHNOLOGIES, INC.
Patent Owner

Case No. IPR2016-00592

Patent No. 9,135,737 B2

DECLARATION OF DR. CHANDRAJIT L. BAJAJ

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I, Chandrajit L. Bajaj, PhD, of Austin, Texas declare that:

I. ASSIGNMENT

1. I have been retained by counsel for Eagle View Technologies, Inc. (“Eagle View” or “Patent Owner”). I understand that the Patent Trial and Appeal Board (“PTAB” or “Board”) has instituted an *inter partes* review (“IPR”) of Eagle View’s U.S. Patent No. 9,135,737 B2 (the “’737 patent”) based on a petition filed by Xactware Solutions, Inc. (“Xactware” or “Petitioner”).

2. I have been asked to opine on the subject of validity of claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 in light of the grounds at issue in this *inter partes* review:

Ground	Reference(s)	Basis (35 U.S.C.)	Claims Being Reviewed
3	Avrahami and AppliCad	§ 103(a) obvious	1, 9, 16, 19, 22, 25–28, 31, 34–36
4	Avrahami, AppliCad, Perlant	§ 103(a) obvious	10

3. In forming my opinions as set forth in this declaration, I have relied upon my education, research, training, and experience in the area of computer science, mathematics, image processing, and visualization. I have also relied on my review and analysis of the art and information provided to me in connection with this case.

4. I am being compensated for my work as an expert with respect to this *inter partes* review, but my compensation is not contingent in any way on the content of my opinions or the outcome of this proceeding.

II. QUALIFICATIONS

5. My curriculum vitae (“CV”) is attached hereto as Exhibit 2009 and provides an accurate identification of my background and experience.

6. I am currently employed as a Professor of Computer Science at the University of Texas at Austin (“UT Austin”). I currently hold the Computational Applied Mathematics endowed Chair in Visualization. I am also the Director of the Computational Visualization Center at UT Austin, which has been funded by the National Institutes of Health, the National Science Foundation, the Department of Energy, and the Department of Defense. The center personnel include fifteen researchers, scientists, post-graduate students, and staff.

7. I have a Bachelor of Technology degree in Electrical Engineering, which I obtained from the Indian Institute of Technology in Delhi (IITD) in 1980. I also have a Master of Science degree and a Doctorate in Computer Science from Cornell University in 1983 and 1984, respectively.

8. Prior to my employment at the University of Texas, I was an assistant professor, then associate professor, and finally professor of Computer Sciences at

Purdue University (Purdue) from 1984 until I resigned in 1997 and transferred to UT. During this time, I was also the Director of Image Analysis and Visualization Center at Purdue University. I was a visiting associate professor of Computer Science at Cornell University from 1990–1991. I have also been invited for collaborative visits by several academic institutions, and have presented numerous keynote presentations worldwide. I have been an editorial member of the SIAM Journal on Imaging Sciences, and the ACM Transactions on Graphics, and continue my editorial role for ACM Computing Surveys and the International Journal of Computational Geometry and Applications.

9. I have spent the better part of my career, both at Purdue and UT, researching, designing, teaching and using computer systems to model, simulate and visualize natural and synthetic objects combining computational image and geometry processing. I am knowledgeable about and have much experience in both the hardware and software, including algorithms, used for capturing, analyzing, and displaying interactive imagery.

10. In the 1970s, while majoring in Electrical Engineering at Indian Institute of Technology with a minor in Computer Sciences, I was intimately involved in the design and fabrication of microprocessor-controlled circuits including the development of microprocessor controller software. In the 1980s,

while at Cornell University, these past experiences led to research in computational geometry, processing and optimization. In the early 1990s, I created 3D collaborative multimedia software environments which were fully navigable for multi-person computer gaming and simulation. In 1994, I co-authored a technical paper entitled “Shastra: Multimedia Collaborative Design Environment,” V. Anupam, C. Bajaj (1994). IEEE Multimedia, 1(2):39-49. The need for increasing computer graphics display realism without sacrificing interactivity led me also to explore image processing techniques such as texture mapping with data compression, such as described in my publication “Compression-Based 3D Texture Mapping for Real-Time Rendering,” C. Bajaj, I. Ihm, S. Park (2000). Graphical Models, 62(6):391-410 and “3D RGB Image Compression for Interactive Applications,” C. Bajaj, I. Ihm, S. Park (2001). ACM Transactions on Graphics, 20(1):10-38.

11. In the mid-2000s, I began to create spatially-realistic 3D graphical environments of nature’s molecules and cells with a combination of different types of acquired and reconstructed imagery within which a user may explore, query, and learn. My publication titled “From Voxel Maps to Models” that appeared in an Oxford University Press book called “Imaging Life: Biological Systems from Atoms to Tissues,” is an example of my research in computational imaging. Over

the course of my career, I have participated in the design and use of several computer systems spanning handhelds, laptops, graphics workstations to PC/Linux clusters as well as very large memory supercomputers for capturing, modeling and displaying virtual and scientific phenomena. My experience with computer modeling and displaying computer graphics imagery encompasses many fields, such as interactive games, molecular, biomedical and industrial diagnostics, oil and gas exploration, geology, cosmology, and military industries.

12. During this time at UT Austin, I also designed and implemented scalable solutions for inverse problems in microscopy; spectroscopy; biomedical imaging; constructing spatially realistic and hierarchical 3D models; development of search/scoring engines for predicting energetically favorable multi-molecular and cellular complexes; and statistical analysis and interrogative visualization of neuronal form-function. Additionally, I have courtesy appointments and supervise M.S. and Ph.D. students from several UT departments, including, biomedical and electrical engineering, neurobiology, and mathematics. I currently serve on the editorial boards for the International Journal of Computational Geometry and Applications, and the ACM Computing Surveys. Much of my work involves issues relating to interactive image processing, 3D modeling, bio-informatics,

computer graphics and computational visualization. Examples of my publications, including peer-reviewed publications, are listed in my CV.

13. As set forth in my CV, I have authored approximately 150 peer-reviewed journal articles, 33 book chapters (which were also peer reviewed), and 142 peer-reviewed conference publications.

14. I have written and edited four books, on topics ranging from image processing, geometric modeling and visualization techniques, to algebraic geometry and its applications. I have given 165 invited speaker keynote presentations. I am a Fellow of the American Association for the Advancement of Science, a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), a Fellow of the Society of Industrial and Applied Mathematics (SIAM), and also a Fellow of the Association of Computing Machinery (also known as ACM), which is the world's largest education and scientific computing society. ACM Fellow is ACM's most prestigious member grade and recognizes the top 1% of ACM members for their outstanding accomplishments in computing and information technology and/or outstanding service to ACM and the larger computing community.

III. MATERIALS CONSIDERED

15. The materials I considered include the '737 Patent, the '737 patent's file history, the Petition from Xactware for *inter partes* review (Paper 9) (as far as it is relevant to the instituted grounds), the Harold Schuch Declaration in support of the Petition (Ex. 1007) (as far as it is relevant to the instituted grounds), the Patent Trial and Appeal Board ("PTAB") decision to institute *inter partes* review (Paper 14), and the Patent Owners' Preliminary Response (Paper 10).

16. I also considered the following materials that I refer to and that I cite in this declaration:

- a) An article by Avrahami et al "Extraction of 3D Spatial Polygons Based on the Overlapping Criterion for Roof Extraction from Aerial Images", ("Avrahami") (Ex. 1004);
- b) A user guide by AppliCad Ltd, entitled "Product Bulletin: Key Features of our Roofing Software ("AppliCad") (Ex. 1005); and
- c) An article by Perlant, et al. "Scene Registration in Aerial Image Analysis" ("Perlant") (Ex. 1006).

17. In addition, I have drawn on my experience and knowledge, as discussed above and described more fully in my CV, in the areas of image processing, interactive 3D modeling, computer graphics and visualization.

IV. PERSON OF ORDINARY SKILL IN THE ART

18. It is my understanding that a person of ordinary skill in the art ("POSITA") at the time of the effective filing date of the application that led to the

'737 patent is someone with a bachelor's degree or higher in computer science, computer engineering, computer vision or visualization, physics, or an equivalent educational background, or someone having at least 5 years of industry experience in software development.

V. SUMMARY OF U.S. PATENT NO. 9,135,737 B2

19. The '737 patent issued on September 15, 2015 from Application No. 14/450,108, which was filed on August 1, 2014. Ex. 1001 ('737 patent) at Cover. That application is a continuation of Application No. 13/474,504, which was filed on May 17, 2012 (which is now Patent No. 8,825,454), which is a continuation of Application No. 12/467,250, which was filed on May 15, 2009 (which is now Patent No. 8,209,152).

20. The '737 patent is directed to “user interface systems and methods for roof estimation.” *Id.* at Abstract. A roof report based on a model is created that may include roof measurement information, such as “one or more plan (top-down) views of the model, annotated with numerical values for the slope, area, and/or lengths of the edges of at least some of the plurality of planar roof sections of the model of the roof.” *Id.* at 6:31–34. “The report may also include information about total area of the roof, identification and measurement of ridges and/or valleys

of the roof, and/or different elevation views rendered from the 3D model.” *Id.* at 6:34–38.

21. The inventions of the ’737 patent are useful in a variety of roof estimation contexts, whether it be for a roof contractor to repair or replace a roof, or to install solar energy panels. *Id.* at 1:28–37, 56–62. In such contexts, the accuracy of the three-dimensional model generated and in turn the resulting roof report are important considerations in evaluating to the ultimate usefulness of a roof estimation procedure that relies on aerial images instead of in-person physical measurements of the roof.

22. To that end, the ’737 patent uses a first and second aerial image of a building to construct a three-dimensional (3D) model, through co-registration of the images onto a 3D grid. Importantly, the ’737 patent includes displaying a first and second aerial image of a roof during the process of generating a roof estimate report. *Id.* at 22:39–44. User indicated features are displayed on the screen by overlaying them on the aerial images of the roof. *E.g., id.* at 14:57–60.

23. One advantage of projecting the indicated features onto the first and second aerial images is that it provides to the user “feedback regarding the accuracy of the roof model, the image registration, etc.” *Id.* at 3:33–34. For example, if a tree is blocking part of a roof in one view, it may not be possible to

add certain features or verify the correctness of the model from that perspective. In another example, that the wire frame is aligned to the roof may not be apparent in one image, but may be apparent in another.

24. With this in mind, the claimed invention permits “the operator [to] switch between various images of the building of the roof 407, making refinements to the 3D model by adjusting the wire frame in whichever image is more convenient and/or provides a more suitable perspective/view of the model.” *Id.* at 14:47–50; *see also* 15:38–46. These changes are then propagated to the other view of the roof, so that the user can continue to make changes or verify the accuracy of the model.

VI. CLAIM INTERPRETATION

25. I understand that claims in an IPR are given their broadest reasonable interpretation in light of the specification as it would be interpreted by one of ordinary skill in the art.

26. I understand that petitioner has proposed the following interpretations for terms with respect to this IPR.

A. “reference grid”

27. I disagree with Mr. Schuch’s opinion that a person of ordinary skill in the art would understand “reference grid” to mean “a data structure to which one or

more aerial images are registered.” Ex. 1007 ¶ 38. This definition is overly broad because it merely requires a data structure of any kind and not one that is a grid, and certainly not a grid that corresponds to the three-dimensional model being modified, as required by claim 10. Mr. Schuch does not identify any support in the specification of the ’737 patent for his interpretation. As the specification explains, “[t]he uniform 3D reference grid is used as a coordinate system for a 3D model of the roof.” Ex. 1001 at 9:56–57. Furthermore, registration allows “an operator to indicate a roof feature on an image (such as a roof edge), which may then be translated from the coordinate system of the image to the coordinate system of the reference grid, for purposes of including the indicated feature in the 3D model.” *Id.* at 9:58–62. Accordingly, Mr. Schuch’s definition is not appropriate because it allows for data structures other than those relating to a three-dimensional grid and I do not believe that this term needs further clarification.

VII. PETITIONER’S PROPOSED GROUNDS DO NOT SHOW THE CLAIMS OF THE ’737 PATENT ARE UNPATENTABLE

A. Background On Asserted References

1. Avrahami

28. Avrahami discloses a study to test an algorithm “for semi-automatic 3D spatial polygon extraction from a pair of colored aerial images with a known external model solution.” Ex. 1004 at Abstract. To achieve its goal, the algorithm

assumes that the two images are significantly overlapping. *Id.* at 43. The proposed algorithm requires minimal user-input in that the operator needs only to “point at every distinct planar part of the roof in the left image space,” after which time the algorithm is fully automatic. *Id.* at Abstract. The reference presents the algorithm, an experiment where the algorithm was applied, and results comparing the accuracy of the semi-automatic algorithm compared to a manual approach.

29. One computation relied upon by Avrahami is the use of epipolar geometry. Epipolar geometry is a way to describe the geometric relationships of two perspective views or images of a scene. These views may be acquired simultaneously as in a stereo rig (like with your own eyes or a pair of binoculars), or acquired sequentially, for example, by a camera moving relative to the scene. These two situations are geometrically equivalent. When two cameras view a 3D scene from two distinct positions, there are a number of geometric relations between the 3D points and their projections onto the 2D images that lead to linear relationships between the same image points in two different images (i.e., a homologous pair of points). Each view has an associated camera matrix, P and P' , where P' indicates entities associated with the second view. A 3-space point X is imaged as $x = PX$ in the first view, and $x' = P'X$ in the second. Image points x and x' are “homologous” because they are the image of the same 3-space point X .

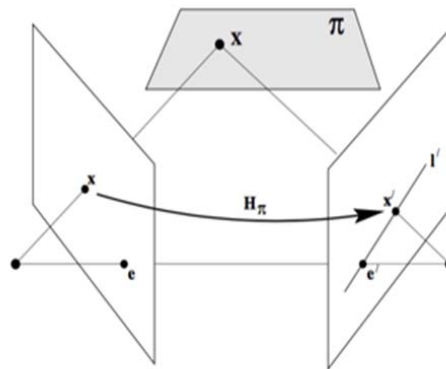


Fig. 9.5. A point x in one image is transferred via the plane π to a matching point x' in the second image. The epipolar line through x' is obtained by joining x' to the epipole e' . In symbols one may write $x' = H_\pi x$ and $l' = [e']_x x' = [e']_x H_\pi x = Fx$ where $F = [e']_x H_\pi$ is the fundamental matrix.

Figure excerpted from Chapter 9 of Multiview Geometry in Computer Vision, 2nd ed., Richard Hartley, Andrew Zisserman, Cambridge Univ. Press, 2000, 2003.

30. Figure 2 below “illustrates a flowchart of the proposed algorithm.”

Ex. 1004 at 46. The algorithm is broken up into three main stages once it is given a pair of colored aerial images: (1) “[m]anual pointing - seed points (in 2D) to the centre area (in a typical radiometric point) of each roof plane in the left image space”; (2) an “automatic process for extraction of the roof planes for each seed point”; and (3) the “[t]opology between the planes is built, the planes are intersected and the outcome is a 3D roof.” *Id.* at 46. In the below diagram, the steps within the bracketed “For 1:n” loop comprise the second stage of the algorithm and are carried out once for each “seed point” selected in the first step. *Id.* at 46.

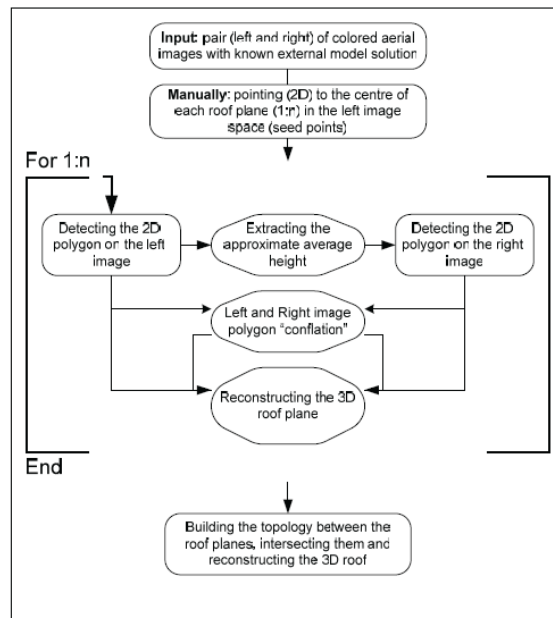


Figure 2. Flowchart of the roof extraction

Id. at 46.

31. The first step of the algorithm is for a user or operator to point to the center of each individual roof plane of the subject roof in an image (called the “left” image). *Id.* at 44, 46. The algorithm disclosed by Avrahami does not require the user to perform any tasks on the right image, and does not disclose even showing that image to the user. This “seed point” is utilized by the algorithm as a starting point to search for the bounds of a particular roof plane section, though the indication of the “seed point” itself does not tell the algorithm where the bounds of the roof reside. This step is the only manual aspect of the algorithm and all other steps are fully automatic. *Id.* at 43 (“1) manual pointing to the center of a well-defined area in the left image space by the operator. This stage defines the

algorithm as semi-automatic and ***from here on the process is fully automatic.***") (emphasis added). At the time the "seed point" is input by the user, the algorithm has not yet started and there are no lines or polygons that have been created.

32. The second step of the algorithm is to automatically extract individual roof planes for each "seed point" selected by the user. *Id.* at 46. This second step involves a series of five sub-steps (i) - (v), explained below, that are carried out only once for each area to be extracted. *Id.* at 44-46 (Sections 3.1 to 3.5). At the end of the second step, the algorithm of Avrahami has not yet created an integrated model of the subject roof, but rather has only incrementally created individual polygons that have yet to be fit together.

33. Sub-step (i) involves determining the 2D bounds of the roof area based on the initial "seed point" in the left image, because the selection of a "seed point" itself does not provide information regarding any bounding lines or points of the roof. *Id.* at 44 (Section 3.1). In order to accomplish that task, a "flood fill" operator is utilized to find the bounds of the area. *Id.* at 44. However, as discussed below, in some situations the "flood fill" operator fails to distinguish between two adjacent roof planes and includes multiple roof planes in the 2D polygon that is extracted. *Id.* at 46 (Figure 1).

34. Sub-step (ii) involves automatically estimating the height of the points of the bounding 2D polygon in the left image space. *Id.* at 44 (Section 3.2). This involves a couple of independent procedures. For each vertex of the left image polygon, the algorithm finds the homologous points in the right image space via an Area Based Matching algorithm (ABM). *Id.* at 44-45. Based on the epipolar geometry relationships between two images, an approximate average height is calculated by using the MEDIAN of the heights obtained from determining the optimal match using ABM. *Id.*

35. Sub-step (iii) involves repeating sub-step (i) to determine the bounds of the roof section in the right image space. *Id.* at 45 (Section 3.3). A suitably chosen 2D transformation based on epipolar geometry is used to transfer the initial “seed point” of the left image to corresponding homologous point in the right image space. *Id.* The “flood” fill operation previously discussed in sub-step (i) above is then performed. *Id.* Because this operation is performed independently in the right and left image spaces, the 2D polygons created in the left and right images may be mismatched and not have the same number of points. *See Id.* at 46 (Figure 1).

36. Sub-step (iv) involves “left and right polygon matching” to align the two 2D polygons of bounded roof areas created in sub-steps (i) and (iii). *Id.* at 45

(Section 3.4). This step is necessary because the extraction of polygons—which involves the strategy of, for each vertex (point) in the left polygon, computing the corresponding homologous point in the right polygon by intersection of the epipolar line and the right polygon—can fail because it is “performed automatically” without user input. *Id.* This can occur due to various issues, including “when the number of points in both polygons is not equal, when there is an occlusion in one of the images and the polygons do not represent homologous areas, when there are a number of intersections per point, when a polygon line is parallel to the epipolar line, etc.” *Id.* Thus, the left and right polygons must be first matched or aligned.

37. To accomplish this, an iterative method for maximal matching between the two 2D polygons is used and based on an optimization model called “adjustment by conditions” (Cooper, 1987), namely, the epipolar linear and planar geometry conditions. *Id.* at 45. The optimized solution minimizes the difference between the interior and exterior polygon areas of the two aligned polygons. *Id.* The left polygon “slides” in the direction of the right polygon until the condition is satisfied. *Id.* Perfect registration of these 2D polygons is crucial for the next step of 3D polygon extraction. Otherwise, it leads to spatial error of the 3D roof model. During this sub-step, points of the left and right polygon are not changed.

38. The last sub-step of the loop for each “seed point,” sub step (v), involves creating an individual spatial polygon for the area corresponding to that “seed point.” *Id.* at 46 (Section 3.5). In the previous step, it was discussed that a matching process was necessary because of various potential issues, such as the polygons created in the left and right images having a mismatched number of points. With the left and right polygons having been aligned in the previous step, an “adjacency matrix” is generated that matches the two closest points. *Id.* Unmatched points at the end of this process are deleted, which results in a final bounded polygon. For example, Figure 1 depicts a left polygon with 10 points and a right polygon with 6 points, whereas the final polygon has only 5 points. *Id.* Notably, the user provides no indication of the location of any points, nor does the user provide any indication of the number of points. Instead, the determination is automatic and not based on any user input. From here, a 3D spatial polygon can be extracted using homologous points and epipolar geometry. *Id.* at 45-46. Once a spatial polygon is extracted in Avrahami, it is not modified. The sub-title of Section 3.5 of Avrahami is “Reconstruction of the 3D spatial contour” and corresponds to the box of Figure 2 labelled “Reconstructing the 3D roof plane.” *Id.* at 46. However, “reconstruction” in this context refers not to modifying anything pre-existing, but rather re-creating a real-life roof plane in virtual reality.

This can be seen from uses of the term within Avrahami itself and the titles of other articles listed in the reference section. *Id.* at 44 (“Due to the complexity of automatic reconstruction of 3D reality from aerial images (occlusions, image quality, etc.), each method attempts in its own way to minimize the dependency on radiometric parameters of the image.”), 48 (three separate articles with titles mentioning building reconstruction).

39. As discussed above, the sub-steps (i) to (v) of step 2 of the algorithm are repeated for each “seed point” indicated by the user. These steps are fully automatic and require no input by the user. At the completion of step 2, no three-dimensional model of the roof exists, but instead a collection of individual spatial polygons.

40. The third and final step of the Avrahami process involves extracting the three-dimensional roof of the subject building. *Id.* at 46 (Section 4). As preparation for this step, the algorithm requires that each polygon includes only one seed point. *Id.* If there are two or more seed points for a single polygon, then these points must be merged and consequently the areas which are represented by the points are also merged. *Id.* These preparations are performed fully automatically and I see absolutely no indication or necessity for user-input. For

example, it would be relatively straight forward for a computer to detect that a 3D spatial polygon is composed of multiple planar surfaces.

41. Once these prefatory tasks are completed, the topology between the roof planes is built up according to adjacency relationships between shared lines composing the 3D planar polygons. *Id.* Finally, spatial intersection of adjacent planes is performed. *Id.* Here, polygon misalignment errors would lead to intersection gaps or extraneous triangles.

42. Thus, the semi-automatic algorithm of Avrahami discussed above, starts with user input at only one time for “seed points” on a single image, and then automatically constructs a single 3D polygonal roof model. However, the algorithm may have spatial accuracy issues, including by possibly missing or extraneous triangles.

43. Avrahami presents a comparison of the accuracy of the results of the proposed algorithm compared to the same roofs “measured manually by an operator in the ERDAS IMAGINE 8.6® software.” *Id.* at 47. As shown Table 1 of Avrahami and as discussed in the reference, the proposed algorithm required less work on the part of the operator, with the tradeoff of achieving less accurate results compared to the manual method. *Id.* at 47, 48.

Table 1. Horizontal and vertical measurement accuracy in both test areas (m).

Accuracy (m)		Test area 1		Test area 2	
		H	V	H	V
1	Manual	0.08	0.13	0.05	0.09
2	Compared	0.17	0.39	0.11	0.22
3	Semi-automatic	0.16	0.37	0.10	0.20

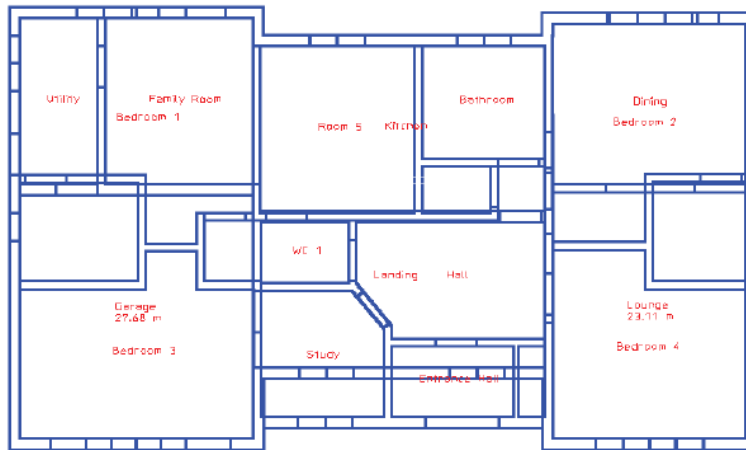
1. AppliCad

44. The AppliCad reference appears to be a product bulletin for CAD (computer aided design) based roofing software that allows a user to draw a 3D roof, from which the software calculates the amount of material needed to cover that roof. Ex. 1005 at 1-2. The target audience of AppliCad appears to be “roofing professional[s]” or end-users of the software.

45. AppliCad does not disclose creating a model of a roof from a pair of aerial images. In order to draw up a roof, AppliCad requires the user to provide certain numeric information about the desired roof. For example, it states that “[p]roviding you enter the dimensions for the perimeter of the roof accurately, and given the correct angle or slope, then the roof generated on the screen should resemble the roof in question.” *Id.* at 3 (Section “2. Drawing up the Roof).

46. As one method of starting the process, AppliCad discloses the importation of two-dimensional roof outlines or floor plans. *Id.* at 4 (Section “3. Importing Roof of Building outlines from another CAD system”). AppliCad

discloses that a 2D CAD drawing can be imported “to get the roof outline in” and shows such an example:



47. After a 2D CAD drawing is imported, the user is required to manually enter certain roof information. *Id.* at 4 (“By using the command *Digitise Outline* we can then move the cursor to the extremities of the wall outline, by ‘snapping’ to those points, **and after entering the pitch or slope of the roof and the eave offset from the wall**, the roof is generated automatically, resulting in an accurate and fast method of working out the areas and lengths.”) (emphasis added).

48. Two other methods are available to start the process. Users can also import 2D roof or building outlines from a scanned 2D image or bitmap. *Id.* at 6 (“We recognize that you may not have the luxury of obtaining the CAD file for the drawing in question, but you may be able to scan the roof plan, using a flatbed scanner.”). In this situation, the user is required to enter “the true measurement

from one reference line” in order to proceed. *Id.* As an alternative to scanning an image, users can also “enter the direction and dimension of each wall to produce the wall outline.” *Id.* at 7. The CAD based software will then proceed to generate a hipped roof model. *Id.* at 9.

49. AppliCad discloses that the user may manually model other roof features, such as multi-hip roofs or first story roofs. Ex. 1005 at 10 (“6. Drawing up Multi-Hip Roofs”), 11 (“7. Drawing up first storey Roofs”), 13 (“8. Modifying the Roof”), 14 (“9. Changing the Pitch of any roof planes.”), 15–16. However, because AppliCad does not rely on the use of aerial images, these modelling tasks are not performed with reference to a 3D wire frame model, projected and overlaid on two aerial images, for 3D model accuracy.

50. Once a model is generated, the AppliCad software will assist in proving costing information, such as the numbers and sizes of flashings and other materials needed for the roof, accounting for issues such as wastage. *E.g., id.* at 25, 28.

51. AppliCad discloses that the user may then print customizable templates that show information generated for the roofing quote, such as a tax invoice, a roofing pay summary, a quotation cutting list, and quotation details. *Id.* at 39–40. The precise contents of these templates is not entirely disclosed by the

user guide and the user guide instructs that “[i]f you wish to receive more information on these outputs, please do not hesitate to contact our office.” *Id.* at 39.

2. Perlant

52. The Perlant reference is titled “Scene Registration in Aerial Image Analysis” and is a paper that surveys algorithms for 2D aerial scene (image) registration, which are used in connection with tasks in the automatic interpretation of 2D aerial imagery. Ex. 1006 at 481 (Abstract). These tasks include (i) automatic structure matching, namely, the automated correlation matching of man-made structures (roofs, buildings) from partially overlapping 2D scene views, (ii) automatic stereo matching, namely, the automated stereo 2D image feature selection, matching and 2D image registration techniques and (iii) stereo visualization, namely, the generation and visualization of stereo disparity images and stereo ground-truth scene segmentations. *Id.*

53. Perlant discusses registering one 2D image with respect to another 2D image. *Id.* at 482. For example, Figures 1 and 4 show a left and right image with a set of gridlines super imposed so that the reader can more easily see the differences in the images. *Id.* at 482, 484. The registration being performed involves

matching to identify the homologous points in both images, including by using isometry. *Id.*

54. Perlant discusses that in order “[t]o get the parameters of the isometric transformation, we need to select points in the same plane that, when transformed, preserve their relative distances with the images.” *Id.* The goal is to match high-level features (lines, corners, etc.) in two overlapping images. *Id.* at 482–483, 488. The matching process relies on the epipolar geometry of the twin 2D views of the same structure. After performing tests using manual and automatic selection of shadow corners, Perlant concludes that “both registrations achieved significantly better results than the CONCEPTMAP coarse registration,” which was based on landmarks. *Id.* at 482–482. Perlant shows the results of several 2D structure matching experiments using the discussed forms of image registration. *Id.* at Figures 5–7.

55. Using epipolar geometry, height information can be calculated for homologous points in the pairs of images. Perlant states that this height information can be used to “visualize the matching results as a three-dimensional scene. *Id.* at 490. However, Perlant does not discuss using registration to a 3D coordinate grid to create a three-dimensional model of any building or roof. Instead, after 2D image space registration has been performed, what is created are

“disparity maps” which show relative heights of areas by varying color of the image. *Id.* at 489 (“In all of the disparity match results presented in this paper, brighter regions are closer to the camera and have greater height. Darker regions are at or below the relative terrain ground plane.”). Perlant presents disparity maps with varying degrees of success. For example, disparity map in Figure 8 shows “huge errors,” whereas the disparity maps in Figures 9, 10, and 13 are “noisy.” *Id.* at 489–490, 492. In another example, Perlant discloses creating a “3D segmentation for ground truth determination” as illustrated in Figure 11. *Id.* at 490. However, Figure 11 is also not a three-dimensional model of a roof, but rather a stereo image that when viewed through a stereoscope can show height disparity.

B. Ground 3: The Combination Avrahami And AppliCad Does Not Render Claims 1, 9, 16, 19, 22, 25–28, 31, 34–36 Obvious

56. It is my opinion that the combination of Avrahami and AppliCad does not render claims 1, 9, 16, 19, 22, 25–28, 31, and 34–36 of the ’737 patent obvious.

1. *Neither Avrahami Nor AppliCad Discloses “displaying . . . a plurality of aerial images of a roof at the same time, each of the aerial images providing a different view, taken from a different angle of the same roof; displaying . . . respective line drawings representing features of a roof” (claim 1) Or “displaying corresponding changes to the line drawing overlaid on the second aerial image” (claim 16) Or “displaying the second line drawing after the first line drawing has been displayed (claim 28)*

57. I understand that Petitioner relies solely on Avrahami to satisfy these limitations, which involve displaying first and second aerial images of a roof. Avrahami fails to disclose or suggest these limitations because, as discussed above, Avrahami only takes user input at a single time, when the user provides initial “seed points” for the left image to start the proposed algorithm. Ex. 1004 at 44, 46. However, there is no suggestion or teaching in Avrahami that both a first and second image need be displayed to the user or ever are displayed. This is not surprising because there is also no teaching or suggestion by Avrahami that a user should view a roof from two different images to modify or verify the accuracy of a three-dimensional model. In fact, the user of the algorithm in Avrahami has no control over the choices made by algorithm once it starts. Though Avrahami shows the left and right images in various figures in the paper itself for purposes of illustrating the algorithm to the reader, there is no suggestion, teaching, or disclosure that these images are displayed to the user of its algorithm.

58. Separately, AppliCad does not deal with aerial images of roofs at all. Thus, I do not believe that a person of ordinary skill in the art would have arrived at this limitation based on the asserted combination.

2. *Neither Avrahami Nor AppliCad Discloses “in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature*

*of the roof that overlies the first aerial image of the roof”
(claim 1)*

59. I understand that Petitioner relies solely on Avrahami to satisfy this limitation, which involves a user providing input to change a line drawing representing a feature of a roof that overlies a first aerial image of the roof.

60. Avrahami does not permit a user to change a line drawing at all. As discussed above, Avrahami permits user input at only a single stage, during the initial selection of “seed points.” Ex. 1004 at 44. After this time, the algorithm is fully automatic. Further, these “seed points” do not permit the user to change a line or indicate where a line should be, but rather are a point at which the algorithm should begin the “flood fill” operation for finding edges of a particular roof plane. *Id.* The “seed point” is not an edge, vertex, ridge, or other part of a wire frame of a roof. Notably, nowhere does Avrahami provide the user with the ability to specify the locations of edges of a roof plane, as that process is completely automatic. Nor does Avrahami provide any functionality to allow the user to change those edges, once they have been determined by the algorithm. Because Avrahami strives to be automatic after the initial “seed point” selection, it teaches away from a user being able to modify a line drawing. Furthermore, at the time the “seed point” is input by the user, the process has not started yet, and therefore there is no line drawing

that could be changed. Accordingly, Avrahami does not teach or suggest this limitation.

3. *Neither Avrahami Nor AppliCad Discloses “in response to the changing, making corresponding changes, by the at least one processor of the roof estimate report system, to the line drawing overlying the second aerial image” (claim 1) Or “in response to changes in the line drawing overlaid on the first aerial image, displaying corresponding changes to the line drawing overlaid on the second aerial image” (claim 16) Or “changing . . . a line in a second line drawing that corresponds to the same feature in the first line drawing that was changed, the change in the second line drawing being made by the computer in response to the change that was made to the first line drawing” (claim 26)*

61. I understand that Petitioner relies solely on Avrahami to satisfy these limitations, which involves changing a line in a second line drawing that corresponds to the same feature of a roof that was changed in a first line drawing.

62. None of the steps carried out by the algorithm in Avrahami involve changing a line in a second line that corresponds to a change in the first line drawing. That is, Avrahami does not make equivalent changes in lines to what it terms the “right” image in response to changes in lines made in the “left” image. For example, when the “flood fill” operator is carried out for the first time in sub-step (iii) (Section 3.3 of Avrahami), the algorithm is not trying to make a corresponding change in a line that the user changed in the left image. Instead, Avrahami carries out a “food fill” operation in the right image that is independent

from the operation that occurred in the left image, such that the polygons in the left and right image very likely do not even match. See Ex. 1004 at Figures 1 and 5.

63. In another example, when the left and right polygon matching process is carried out in sub-step (iv) (Section 3.4 of Avrahami), the algorithm attempts to overlap the left polygon over the right polygon. As discussed above, this is so that differences in the number of points between the left and right polygons can be ascertained and so that later the homologous points between the two polygons can be found and a 3D spatial polygon generated. But during this stage, neither polygon is being changed, and certainly no changes in the right polygon are occurring in response to any changes in lines made in the left polygon.

64. The same is true of the final sub-step (v) (Section 3.5 of Avrahami), as well as the final stage of Avrahami that involves extracting the final three-dimensional roof. For example, when any differences in the number of points in the left and right polygons are reconciled, no line is being changed in the left image and then being propagated to the right. Instead, points may be deleted in one polygon, but not the other. These steps are all automatically performed and do not involve changing the right image to match a change in the left, but rather involve constructing a single three-dimensional polygon based on the data in the left and right polygons. As discussed above, this step is referred to as

“reconstruction” because it attempts to recreate part of the physical roof in a three-dimensional virtual object. Any prefatory steps prior to building the topology for the final three-dimensional model, like the merging process described above, are also done automatically without changing a line in one polygon that is propagated to the right. Furthermore, like with the deletion on points when the left and right polygons are mismatched, any steps performed as a result of the merging process occurs in either the left or right image, so there is no change in the left image that is propagated to the right. Finally, once an individual roof plane is generated, Avrahami discloses no process by which a line of that roof plane may be changed.

4. *Neither Avrahami Nor AppliCad Discloses “generat[ing] and output[ting] a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof” (claims 1, 16, and 26)*

65. I understand that Petitioner relies solely on AppliCad to satisfy these limitations of claims 1, 16, and 26, which involve generating and outputting a roof estimate report that includes certain items. In my opinion, a person of ordinary skill in the art would not combine the Avrahami and AppliCad references in a way that results in the claimed invention because systems described by the two references are not interoperable and because they are directed to disparate purposes. Avrahami discloses an algorithm for extracting roof plane polygons

from a pair of aerial images of a roof of unknown measurements, whereas AppliCad discusses generating a roof model using CAD software starting with an existing floor plan and at least some known measurements.

66. First, I disagree with Mr. Schuch’s contention that “the Applicad system can also import a model generated in another program, in the form of a roof or wall outline in **three dimensions**.” Ex. 1007 ¶ 57 (emphasis added); *see also* ¶ 64. As discussed above, AppliCad does not disclose the ability to import a three-dimensional model of a roof, as indicated by the necessity to input at least some roof measurements, such as roof pitch and possibly the length of one wall. Ex. 1005 at 4–7. That AppliCad also discusses importing a .dxf file (*Id.* at 4) is of no consequence, because such a file can contain two-dimensional roof or building CAD drawing information or two-dimensional scanned information only. Alternative methods of importing information described by AppliCad confirm that only two-dimensional models can be imported. For example, roof or building outlines may be scanned from an image or bitmap file. *Id.* at 5 (“4. Importing Roof of Building outlines from a scanned image or bitmap”). As was the case with the imported .dxf files above, the user is required to “digitize around the outline,” but additionally must enter “the true measurement from one reference line” before a three-dimensional model can be generated. *Id.* at 6. The “Track-Outline”

command similarly requires the user to “enter[] the pitch (or slope), the eave offset and the eave height” (*Id.* at 7–8) before the user can “view the roof in 3 dimensions” (*Id.* at 9). As such, a person of ordinary skill would not understand that AppliCad is interoperable with Avrahami, and so, a person of ordinary skill in the art would not be motivated to combine them.

67. Second, a person of ordinary skill would not be motivated to combine the alleged report generation functionality of AppliCad relied upon by Petitioner with the model generation capabilities of Avrahami because the two references are directed to disparate purposes. AppliCad discloses generating a report—which includes estimates on pricing and materials needed for a roof—after the user has provided known measurements such as a 2D outline and a roof pitch. *Id.* at 4. On the other hand, Avrahami is directed to creating a model of a roof with no inputted measurements at all, based solely on aerial images of the roof. Ex. 1004 at Abstract. However, because Avrahami provides no ability to modify the three-dimensional model, much less a way to review the model for accuracy as it is being generated, a person of ordinary skill in the art would not think to generate a roof report from its output. Indeed, in Avrahami, the only disclosure of verifying its accuracy was by post comparison using results from another computer program. Ex. 1004 at 47–48. Further, while creating a roof report in AppliCad after the user

has designed a roof for a specific floor plan may be logical, doing so after creating a model from a pair of aerial images as in Avrahami is not obvious because the results may not be accurate. Accordingly, a person of ordinary skill in the art would not think to generate a roof report using the algorithm of Avrahami.

68. Third, nevertheless, AppliCad does not disclose the claimed requirements of a roof report. The only report shown in AppliCad does not show a top-plan view of the roof that is annotated with the required values. Ex. 1005 at 40. Though Petitioner cites Figure 1 of Avrahami as showing a top-down plan view of a roof, nothing in Avrahami shows a report annotated with roof measurement information. In fact, because Avrahami only extracts models in a “local coordinate system,” Ex. 1004 at 46, there are no roof measurements that can be annotated on any of the images. Finally, the ’737 patent’s roof report and its contents are intertwined with, and directly improve the functionality of, the underlying method of roof estimation. The usefulness of the roof report is improved by a three-dimensional modeling method that provides accurate results. The claimed values in the roof report—which are generated from the three-dimensional model—allow for accurate estimation of the roof repair.

5. *Neither Avrahami Nor AppliCad Discloses “transmitting roof measurement information based at least in part on the change of the line drawing representing a feature of the roof that overlies the first aerial image of the roof” (claim 9)*

69. Avrahami does not teach or disclose transmitting roof measurement information based at least in part on the change of a line drawing that overlies the first aerial image of a roof.

70. Avrahami does not satisfy the “transmit[ting]” aspect of this element because there is no disclosure of a step in which information is sent externally to the system running the algorithm. See Ex. 1001 at 17:15–21, 7:5–8 (“[r]eports may be transmitted electronically, such as via a network (e.g. as an email, Web page, etc.) or by some shipping mechanism, such as the postal service, a courier service, etc.”). Instead, the algorithm of Avrahami “was developed using the MATLAB® environment, in order to examine the algorithm efficiency.” Ex. 1004 at 46. MATLAB is a tool computer scientists use for computational mathematics, to run simulations, and to perform calculations. There is no indication that any other tool was required to perform the stated purpose of testing the algorithm and examining the three-dimensional model that is created. Thus, merely **extracting** a three-dimensional model—which refers to generating a three-dimensional model from a pair of images—without more, would not constitute transmitting roof measurement information as required by the claims. Nor does implementing the algorithm using MATLAB necessarily mean that information was capable of being transmitted, because the person programming the algorithm would have to program

it to transmit information as part of the proposed method. Furthermore, even if certain information is displayed on a computer screen, this is not transmitting that information, as displaying and transmitting are distinct acts. As such, there is no suggestion or indication that any information generated by Avrahami was transmitted at all.

71. That Avrahami states that generating city models may require both “CAD and GIS systems where the spatial data must be stored in such a way that it can be queried and presented” is of no consequence. Ex. 1004 at 43. This statement is providing general background on the field of building extraction and does not teach that the proposed algorithm should transmit roof measurement data as one of its steps, in the order presented in claim 9.

72. Furthermore, Avrahami does not satisfy the “roof measurement information” aspect of this limitation because Avrahami merely extracts “the 3D roof in a local coordinate system.” *Id.* at 46. A local coordinate system does not give actual measurements of the object that has been modelled. At best, the local coordinate system provides information regarding the location of points in space. By contrast, roof measurement information as required by claim would provide metrics related to dimensions or areas in every day values such as feet or meters. Ex. 1001 at 2:55–58 (“The roof measurement information may include

measurements such as lengths of the edges of sections of the roof, pitches of the sections of the roof, areas of sections of the roof, etc.”)

73. Finally, as discussed above, Avrahami does not disclose changing a line drawing at all, and therefore, there can be no transmitting of any roof measurement information based on such a change.

6. *Neither Avrahami Nor AppliCad Discloses “modifying a three dimensional model of the roof based at least on the modification of the line drawing overlaid on the first aerial image” (claim 25)*

74. Avrahami fails to disclose modifying a three-dimensional model of the roof based on at least the modification of a line drawing, as required by claims 1, 12, and 16. Whereas the ’737 patent is directed to creating a three-dimensional model of a roof with the aid of user input regarding the actual content of the model in that the user can move particular lines that comprise the model (thus modifying the model), Avrahami attempts to create a three-dimensional model of the roof with only user input of where to start the process (i.e. “seed points”) and decisions regarding the actual content of the model are automatic.

75. First, Avrahami cannot meet this limitation because it does not create a three-dimensional model of the roof until the very end of the disclosed algorithm and thus fails to disclose modifying a model at all. As discussed above, after a first step of selecting “seed points,” Avrahami only creates individual spatial polygons

during the second major step of the algorithm, that will eventually make up the three-dimensional model of the roof. The creation of these individual spatial polygon pieces is not creating (or modifying) a three-dimensional model of a roof, including because the algorithm has not yet determined how they fit together. The composition of each roof plane and the topological assembly or stitching together of roof planes into a three-dimensional roof model is only accomplished after the third and final step of the algorithm. Moreover, Avrahami contains absolutely no teaching or suggestion that once the three-dimensional model of the roof has been created in the third and final step, that a line could be changed to improve its accuracy.

76. Second, as described above, the sub-steps that are performed to create individual polygons are only carried out once per “seed point” and do not include modifying a three-dimensional model of a roof based on a changed line. These steps are performed to create the individual spatial polygons that compose the roof model, not to modify them. For example, the first through third sub-steps (Sections 3.1 to 3.3 of Avrahami) of the algorithm’s overall second major step in bracketed portion of Figure 2 of Avrahami result in two separate two-dimensional polygons in the left and right images after utilizing a “flood fill” operation in which the algorithm attempts to find the edges of a roof plane automatically,

without the user indicating the location of the edges. No three-dimensional model of a roof is created or modified during this step, nor is any line changed to modify a feature of the roof.

77. The fourth sub-step (Section 3.4 in Avrahami) is simply the fully automatic iterative matching process (for finding homologous points in the left and right polygons) that works based on maximizing the overlap of the left and right polygons. No three-dimensional model of a roof is created or modified during this step. Indeed, this iterative process is fully automatic and does not rely on change of a line to provide information about how to accomplish the matching.

78. Nor is a three-dimensional model of a roof modified based on a changed line in the fifth sub-step (Section 3.5 of Avrahami). As discussed above, a single polygon is extracted from the matched left and right pair. Any steps that are performed prior to the generation of an individual polygon, such as reconciling the number of points in the left and right polygons or any prefatory steps prior to building the topology for the final three-dimensional model, like the merging process described above, are not modifications to a three-dimensional model, much less modifications of individual roof planes. Instead, they are part of generation of the individual roof planes in the first instance. Accordingly, none of the steps of Avrahami meet the claimed limitation.

C. Ground 4: The Combination Avrahami, AppliCad, And Perlant Does Not Render Claim 10 Obvious

79. For the reasons set forth below, it is my opinion that the combination of Avrahami, AppliCad, and Perlant does not render claim 10 of the '737 patent obvious. Claim 10 requires the elements of claim 1, plus the additional requirements of “displaying a marker operable to specify a point on an image; receiving, via the marker, an indication of a point on the first aerial image; and registering, based on the received indication of the point, the aerial image to a reference grid corresponding to the three-dimensional model of the roof.” I understand that Petitioner relies on Perlant for the additional limitations of claim 10.

80. As discussed above, Perlant does not “register “the aerial image to a reference grid corresponding to the three-dimensional model.” Instead, it deals with determining a transformation from one 2D image to another 2D image, using epipolar geometry. Furthermore, as discussed above, there is no reference grid that corresponds to a three-dimensional model of a roof because the images shown are merely disparity maps or segmentations that must be viewed through a stereoscope. At best, these images show relative height information, but do not provide point by point locations of vertices of a roof in a three-dimensional grid.

81. A person of ordinary skill would not be motivated to combine Avrahami and Perlant in a way that results in the claimed invention. Avrahami relies on a fundamentally different process to generate a three-dimensional model than the invention of the '737 patent, because Avrahami relies primarily on epipolar geometry to determine the parameters of individual polygons making up the three-dimensional model of the roof, rather than registering points to a three-dimensional reference grid. Thus, the additional processing required to register points to a three-dimensional reference grid is not necessary to accomplish the algorithm described by Avrahami, especially because there is no functionality to modify the three-dimensional model once it has been created in response to user input.

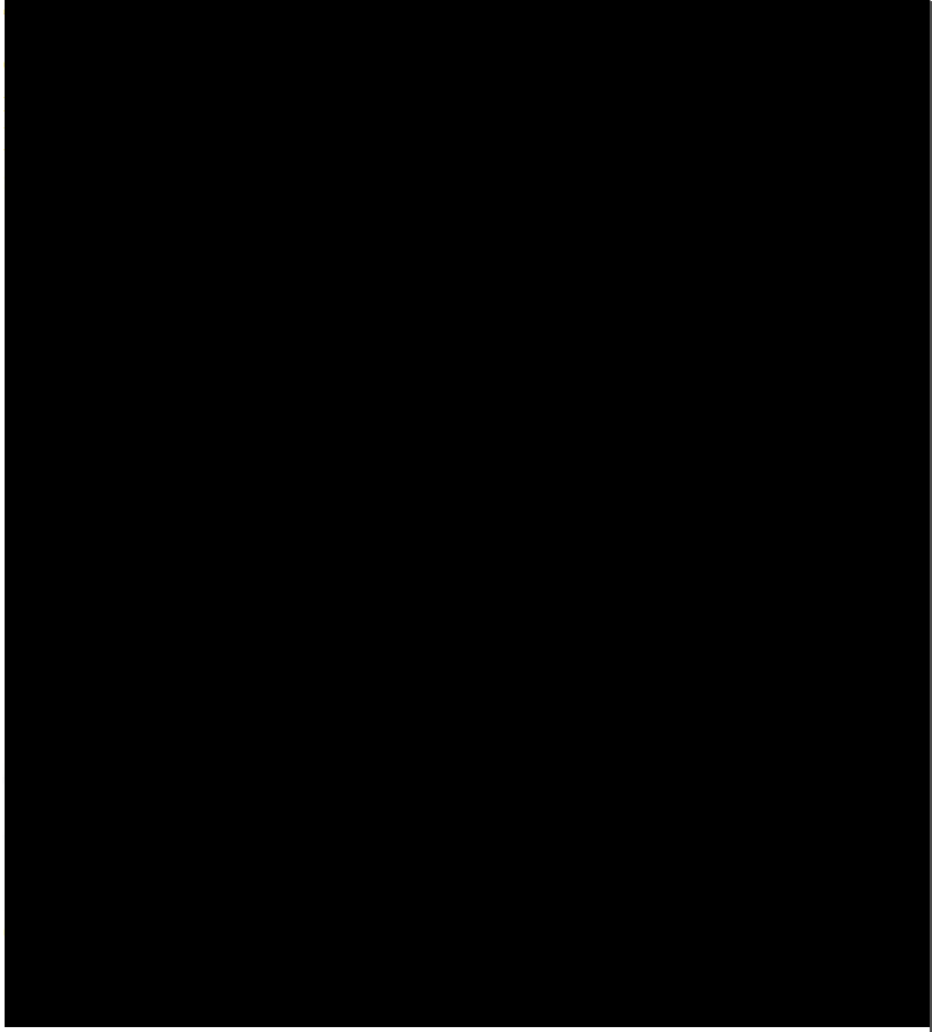
VIII. SECONDARY CONSIDERATIONS OF NON-OBVIOUSNESS

82. I have been asked to opine regarding issues relating to secondary considerations of non-obviousness to support my opinion that claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 of the '737 are patentable. I note that Mr. Schuch did not present any opinions regarding secondary considerations.

83. As discussed above, the art asserted by Petitioner teaches away from the claimed invention and in particular the teaching of the '737 patent to change lines of a line drawing, to modify a three-dimensional model, and to display

projections of that modified model over aerial images, so that the user can verify the accuracy of the model.

84. It is my opinion that Patent Owner's Twister and Render House software products embody at least claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 of the '737 patent. I include below a chart I prepared showing in detail how both the Twister and Render House products embody each and every limitation of these claims of the '737 patent. As part of my analysis I have discussed these products with engineers at Patent Owner who use the Twister and Render House products on a regular basis. During those discussions I personally directed Patent Owner's engineers to operate the Twister and Render House software to confirm my understanding of the products' operation. Based on my analysis of the Twister and Render House products, I have determined that each embodies claims of the '737 Patent. My understanding of the features of the Twister and Render House products are further confirmed based on my review of user manuals for these two products. In my opinion the Twister and Render House software products generate accurate three-dimensional roof models and embody each limitation of claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 of the '737 Patent.

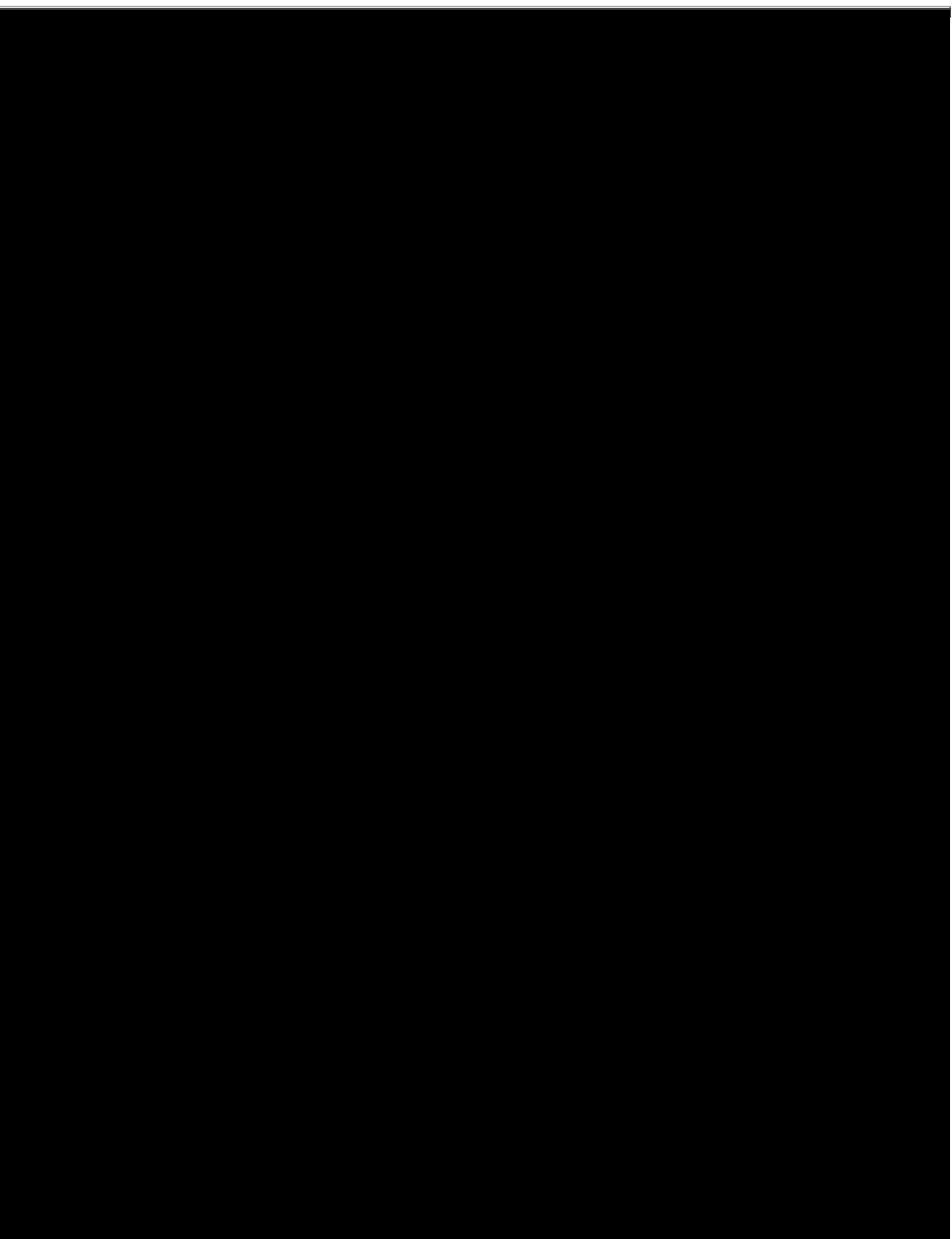
Claim Terms in U.S. Patent 9,135,737	<u>Patent Owner's Twister and Render House Products</u> ¹
Claim 1 [1.a]: A computer-implemented method in a roof estimate report system including at least one processor and a memory coupled to the at least one processor, the method comprising:	

¹ Unless otherwise indicated, all screenshots in this claim chart were taken from version 2818.0 of Twister, and the version of Render House accessed therewith.

[1.b] displaying, by the at least one processor of the roof estimate report system, a plurality of aerial images of a roof at the same time, each of the aerial images providing a different view, taken from a different angle of the same roof;	

[1.c] displaying, by the at least one processor of the roof estimate report system, respective line drawings representing features of the roof, the respective line drawings overlying a first and a	

second aerial
image of the
plurality of
aerial images
of the roof,
the line
drawing
overlying the
first aerial
image of the
roof having
features in
common with
the line
drawing
overlying the
second aerial
image of the
roof;



[1.d] in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature of the roof that overlies the first aerial image of the roof;	

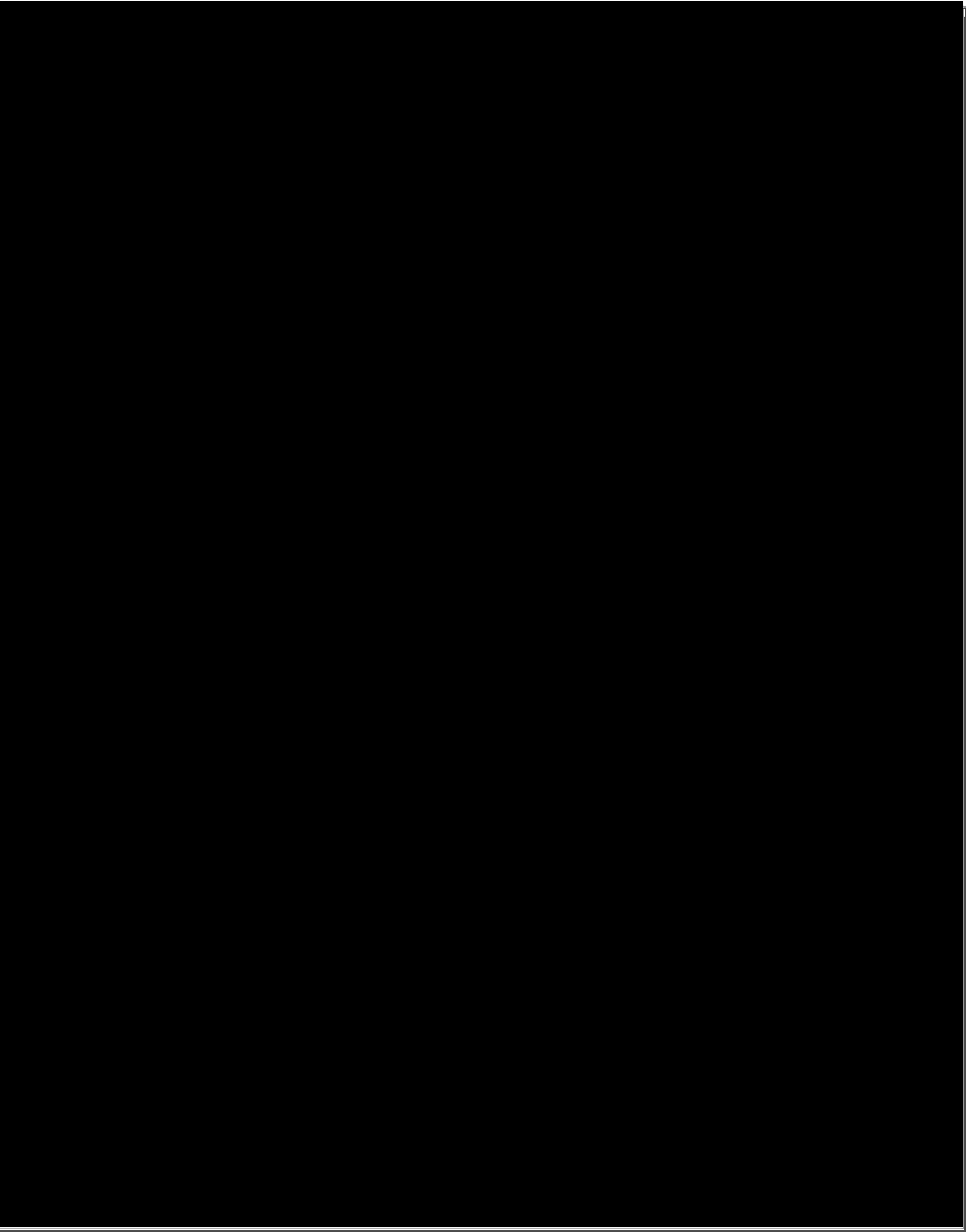


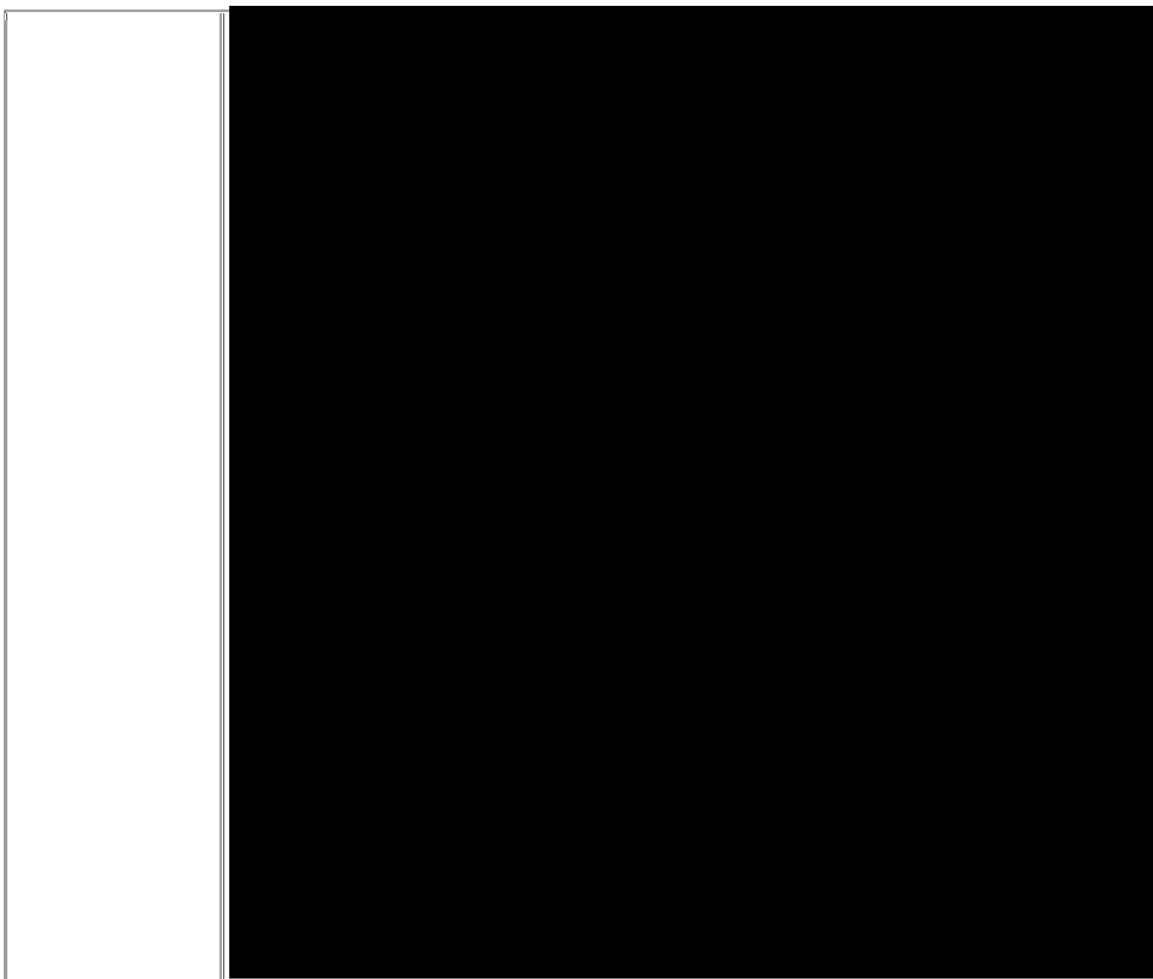
[1.e] in response to the changing, making corresponding changes, by the at least one processor of the roof estimate report system, to the line drawing overlying the second aerial image; and	

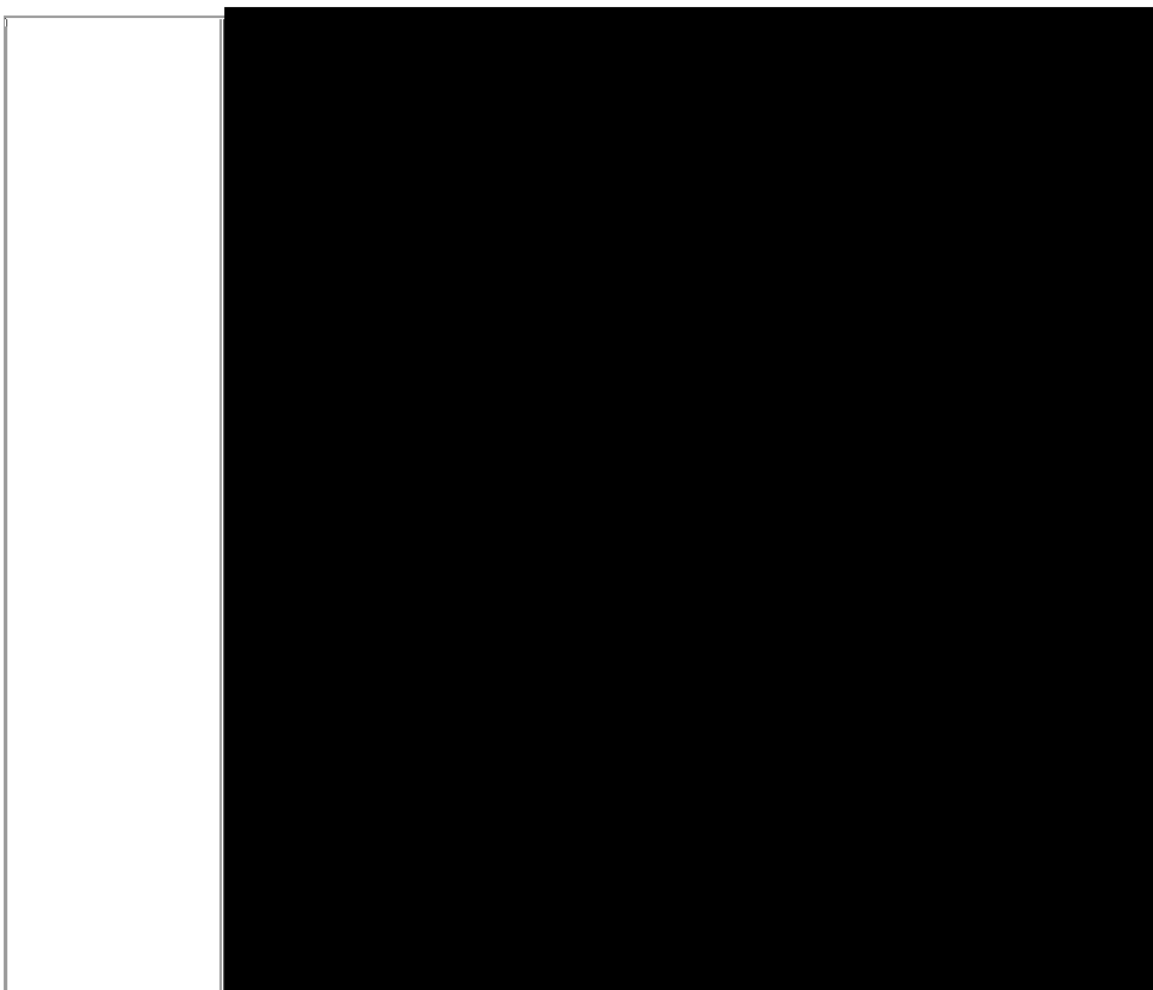


[1.f] generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of	

a plurality of planar roof sections of the roof, wherein the generated roof estimate report is provided for repair and/or constructing the roof structure of the building.





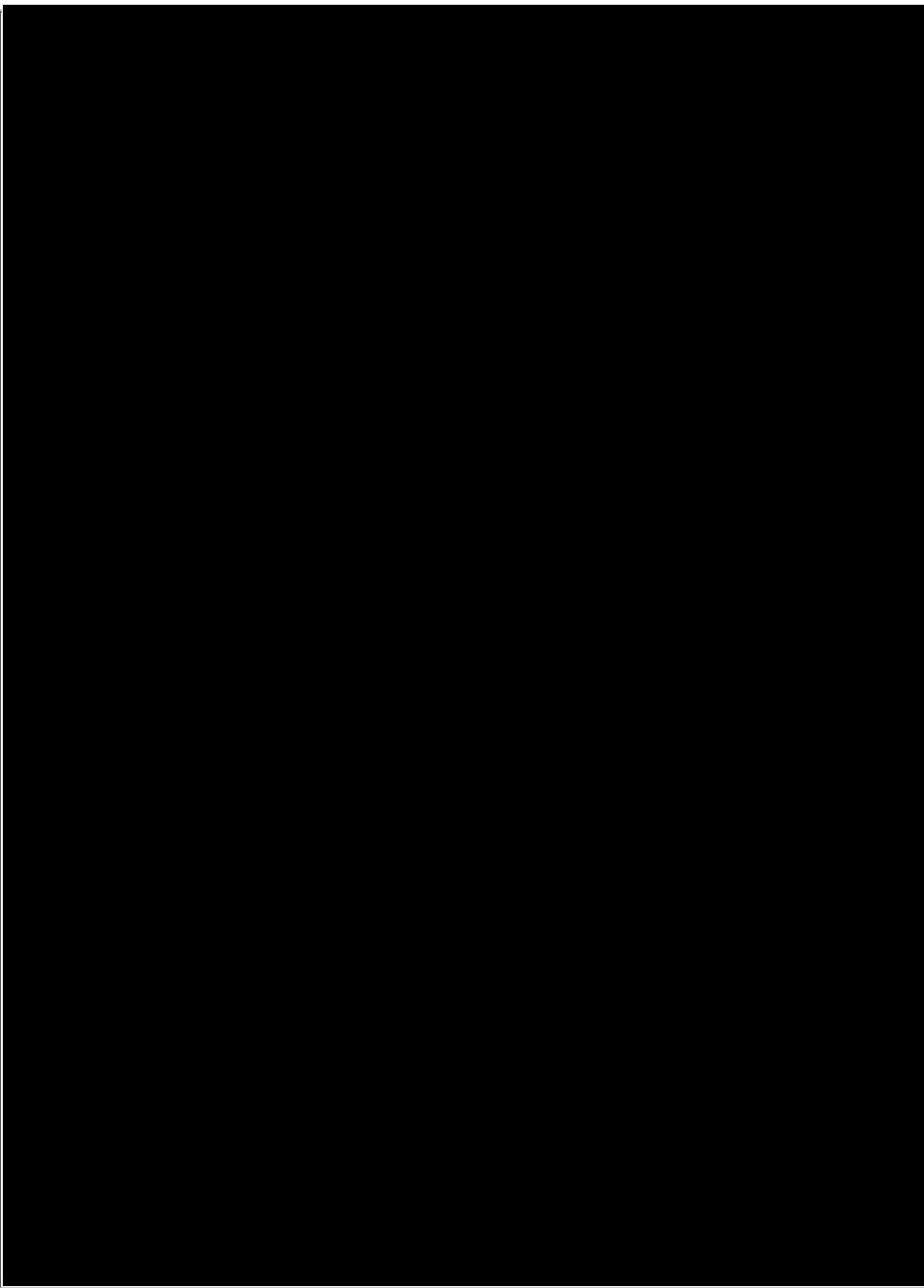




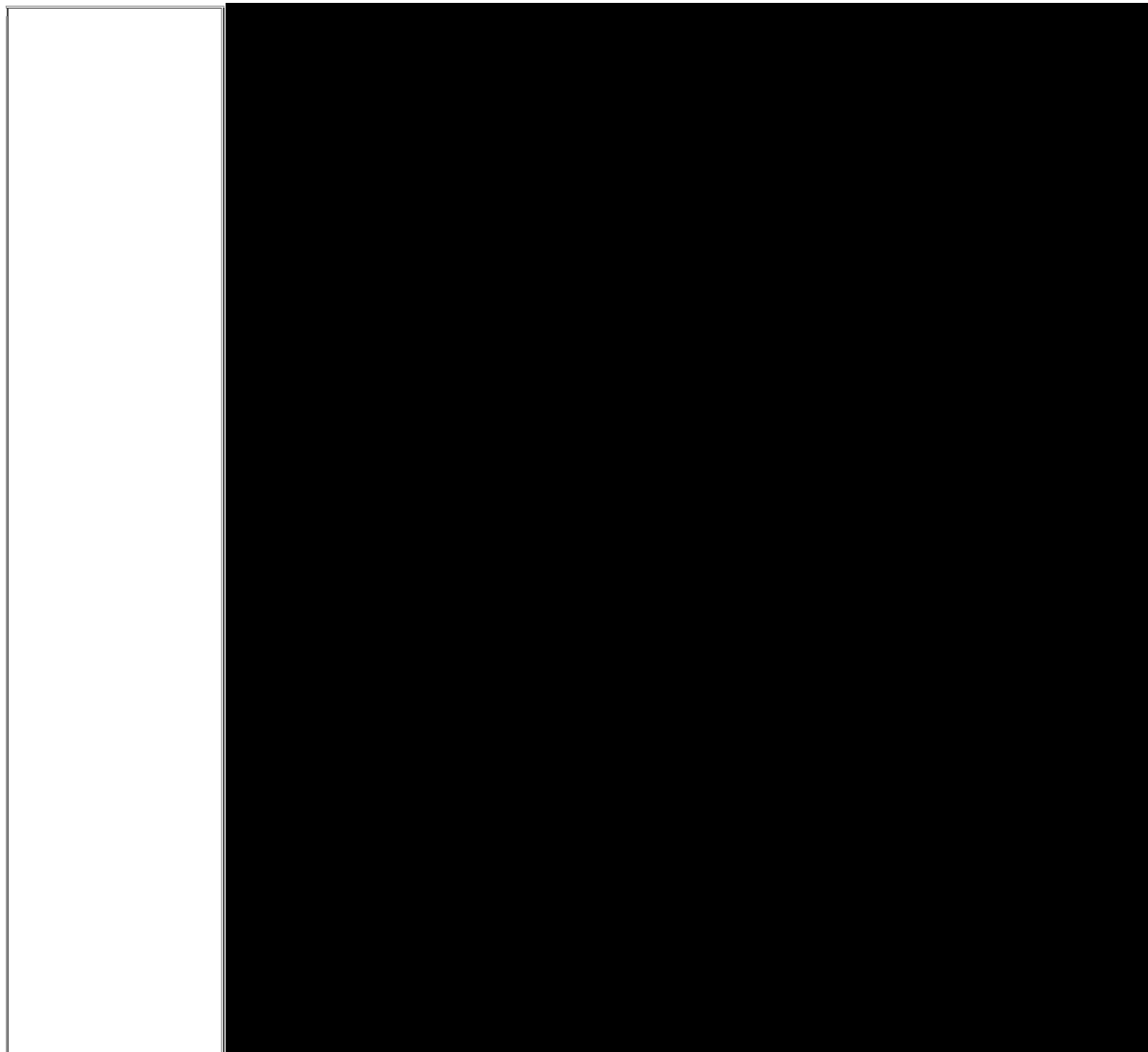
Claim 9: The method of claim 1 further comprising: transmitting roof measurement information based at least in part on the change of the line drawing representing a feature of the roof that overlies the first aerial image of the roof.	

Claim 10 [10.a]: The method of claim 1 further comprising:	

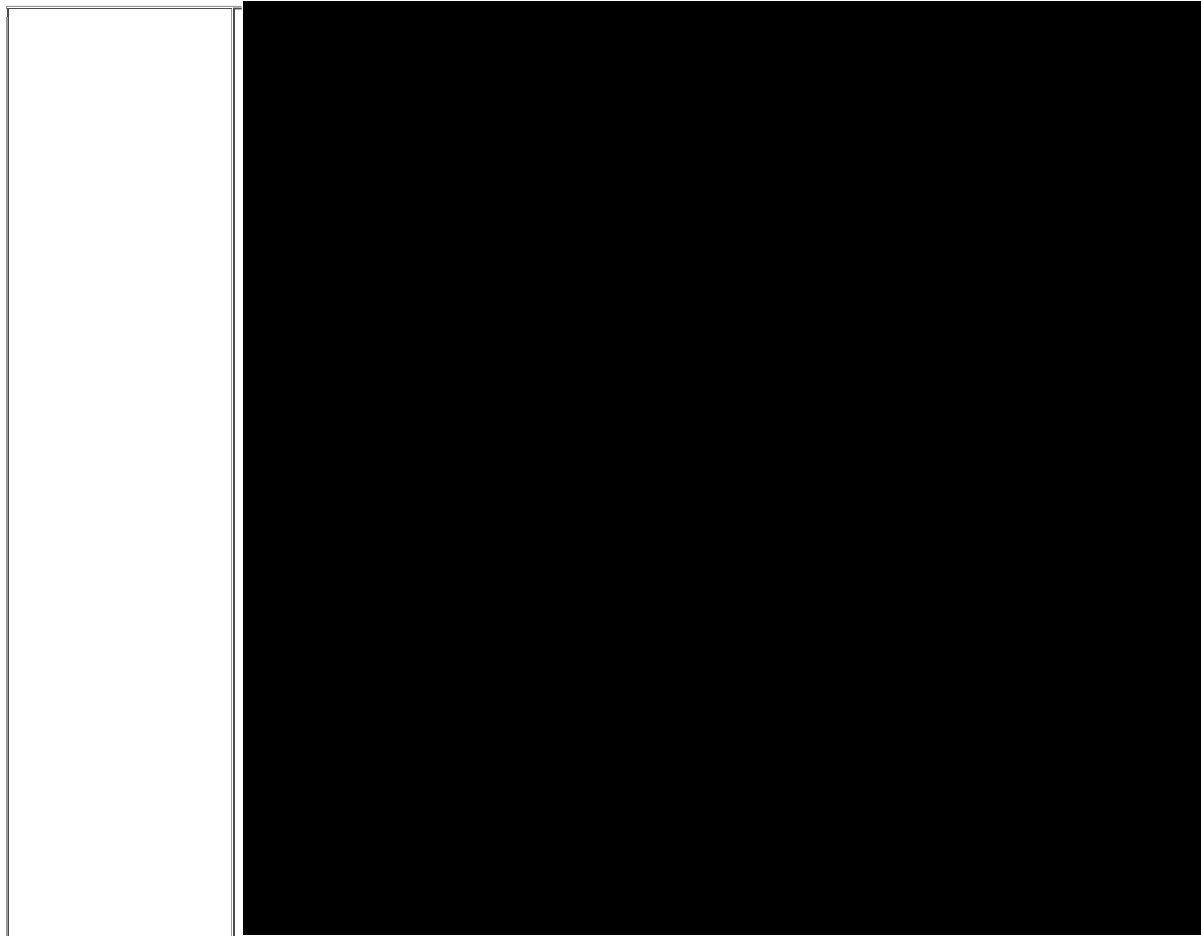
displaying a
marker
operable to
specify a
point on an
image;

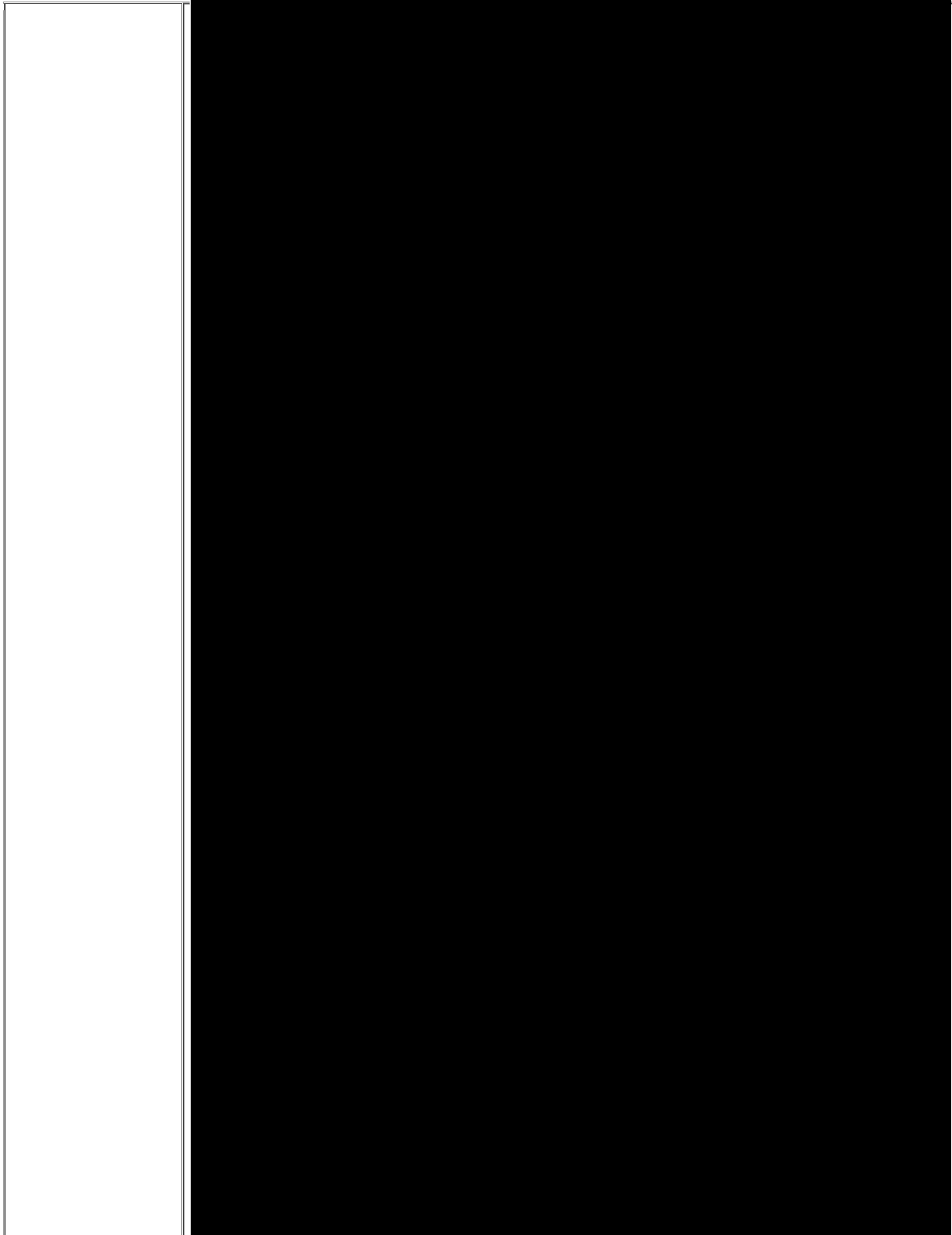


[10.b] receiving, via the marker, an indication of a point on the first aerial image; and	



[10.c]
registering,
based on the
received
indication of
the point, the
aerial image
to a reference
grid
corresponding
to a three-
dimensional
model of the
roof.



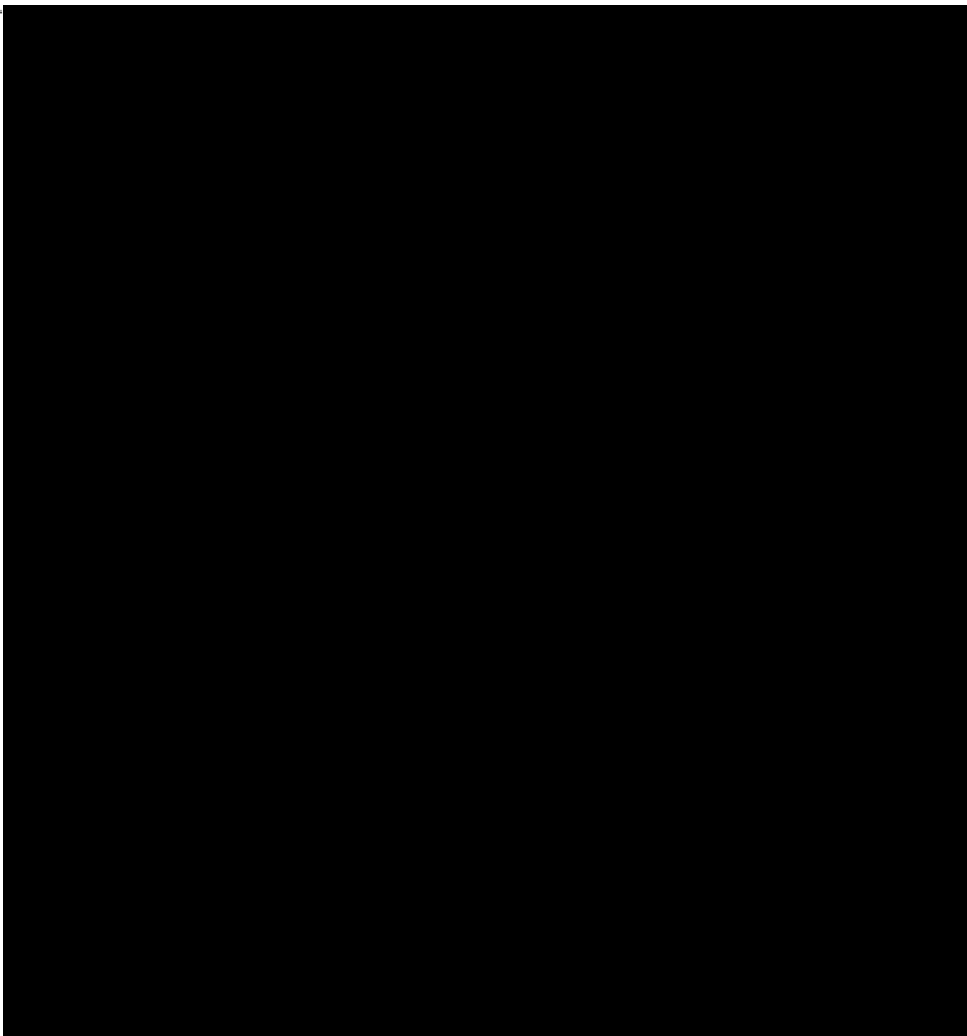


Claim 16 [16.a]: A non-transitory computer-readable storage medium, having computer executable instructions stored thereon that, when executed by at least one computer processor, cause the at least one processor to enable a	

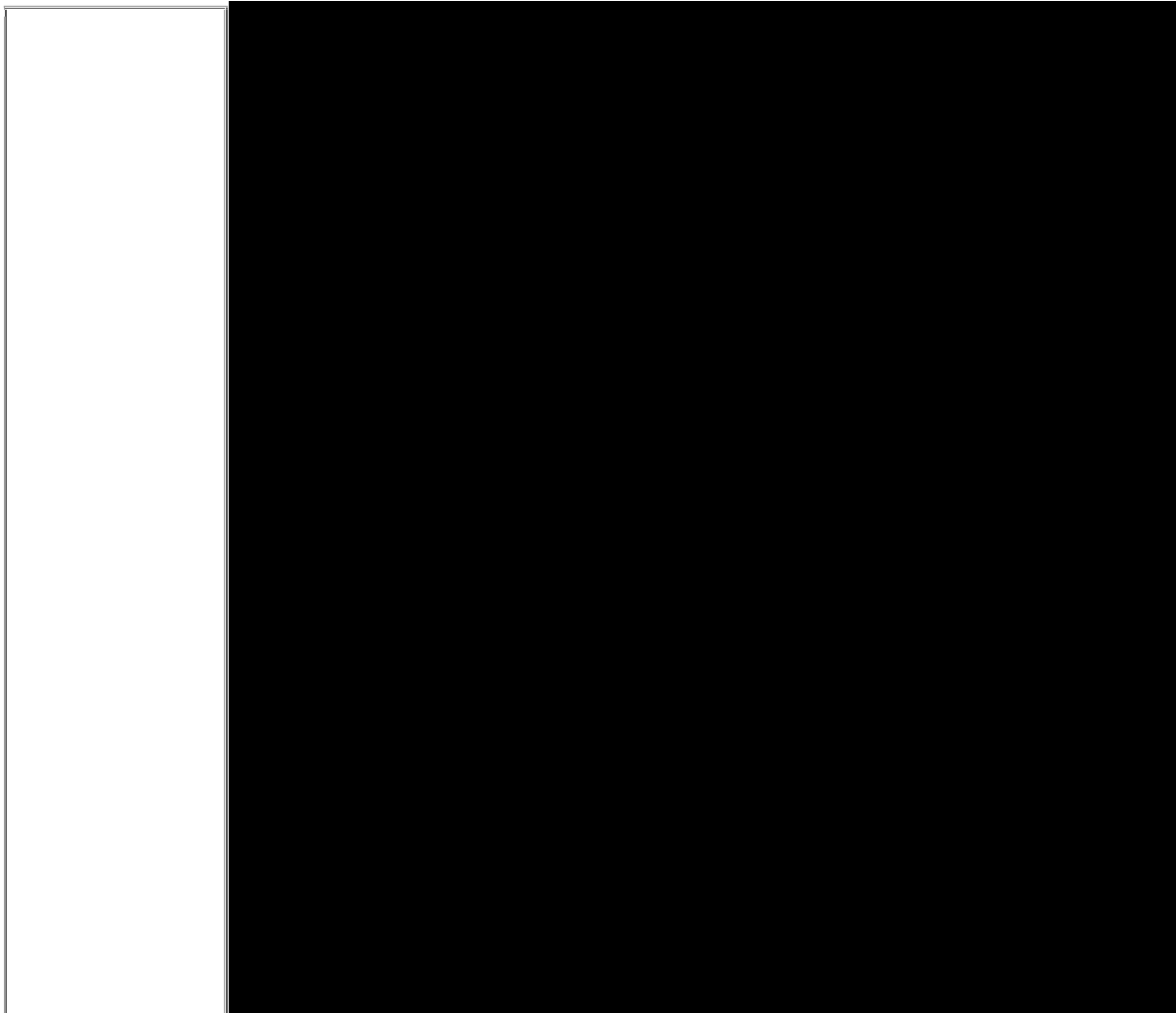
computing
system to
generate a
roof estimate
report for a
building
having a roof,
by performing
a method
comprising:

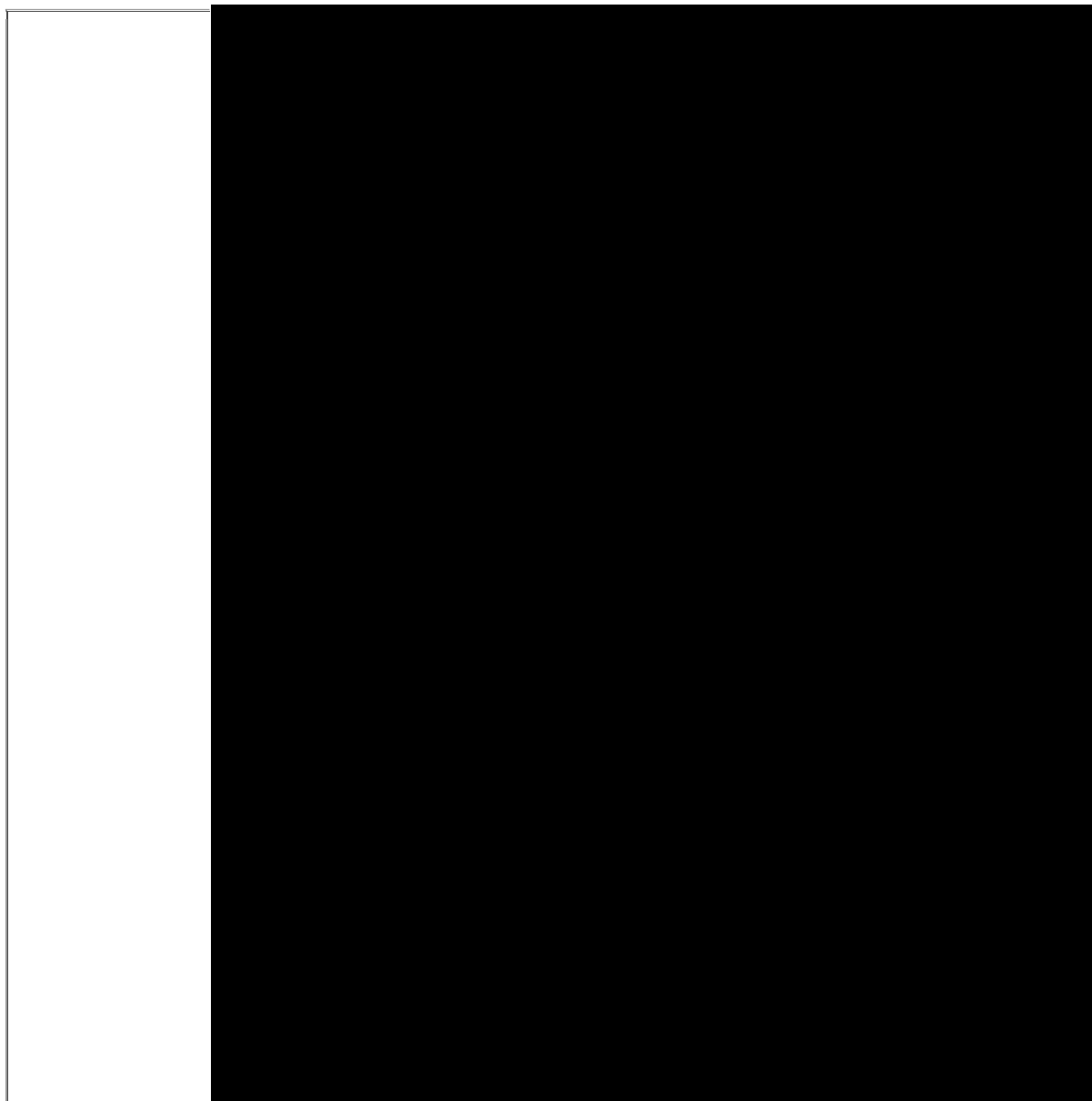
[16.b]
overlaying a
line drawing
on
corresponding
locations of a
roof feature of
the roof on
first and
second aerial
images of the
roof, wherein
the first aerial
image
provides a
first view of
the roof of the
building and
the second

aerial image
provides a
second view
of the roof of
the building;



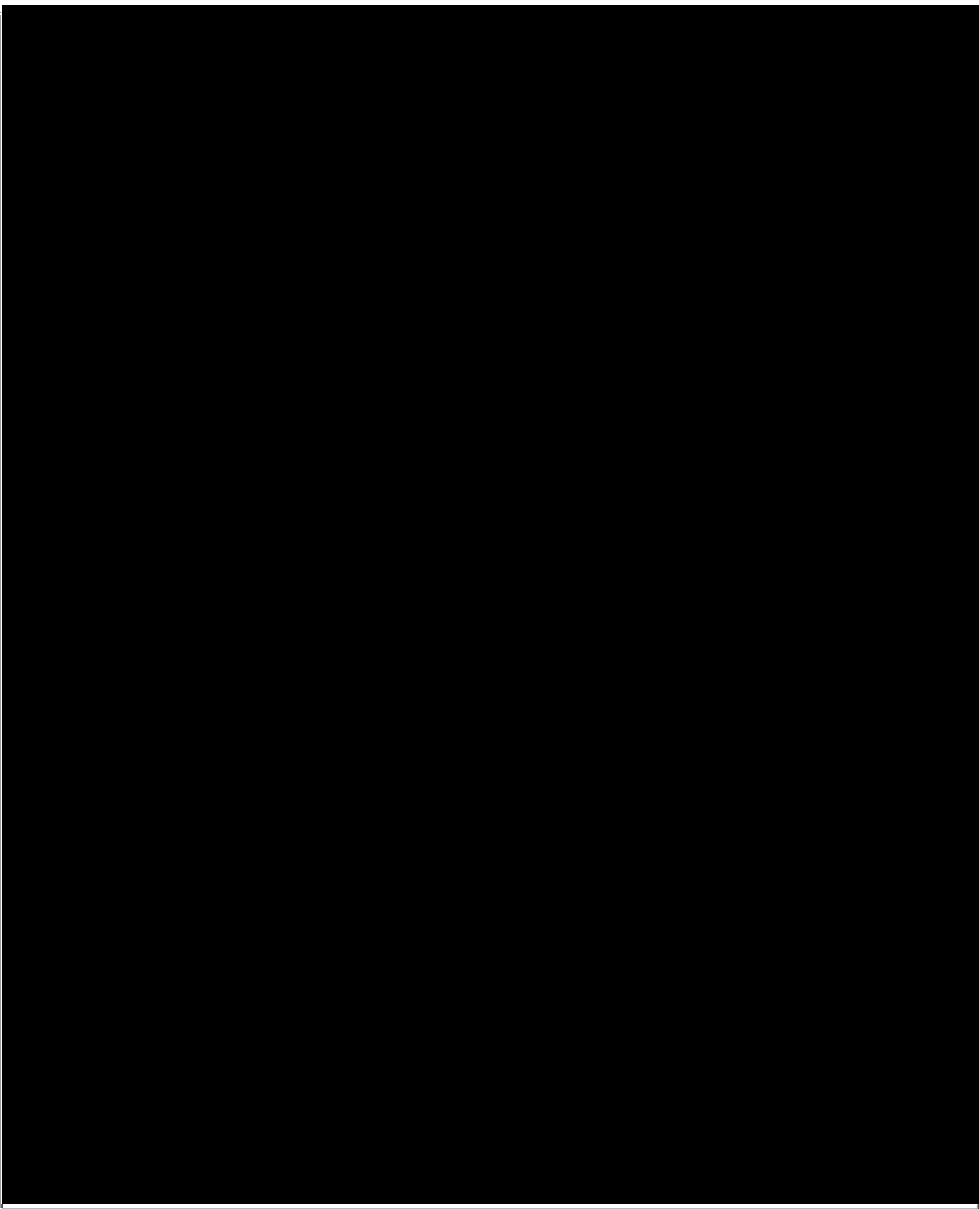
[16.c] in response to changes in the line drawing overlaid on the first aerial image, displaying corresponding changes to the line drawing overlaid on the second aerial image; and

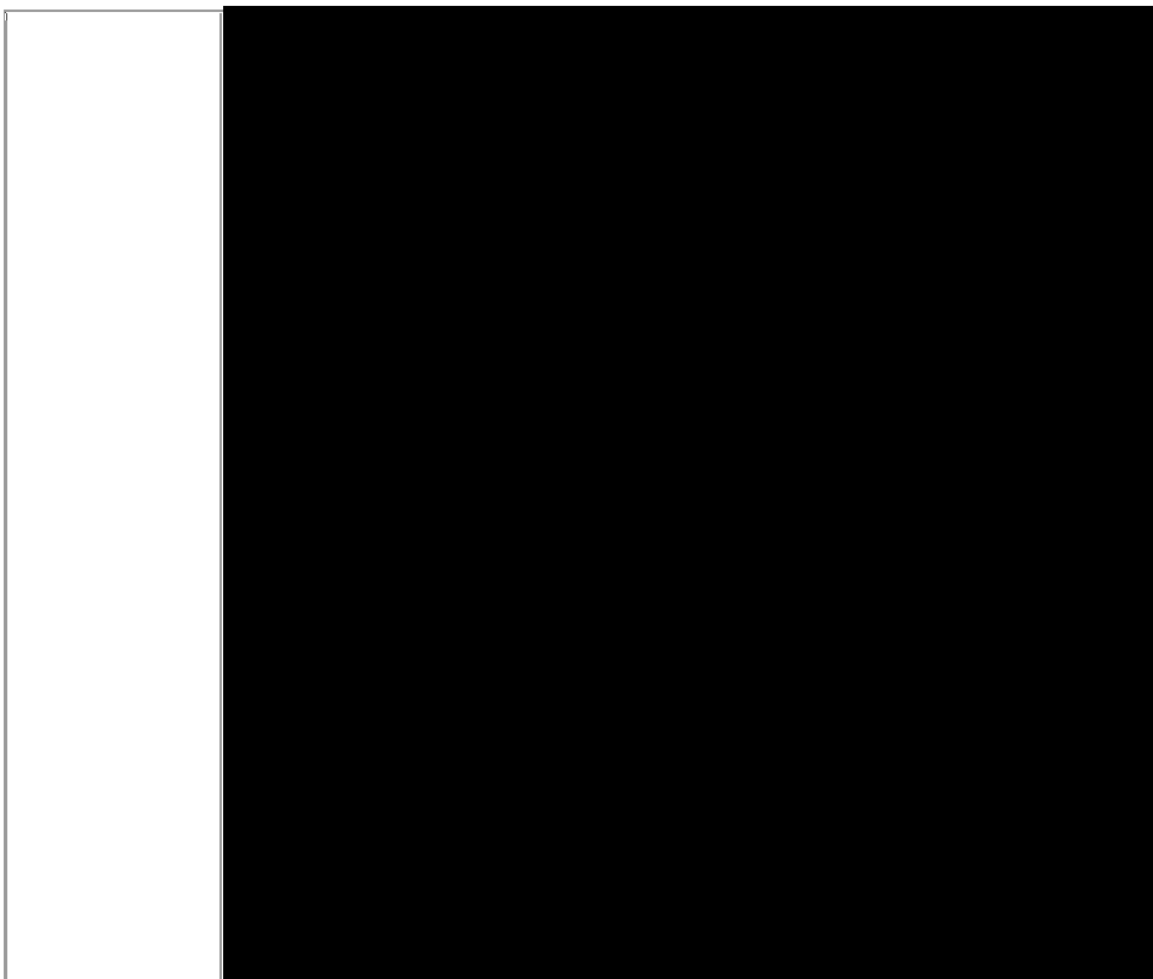


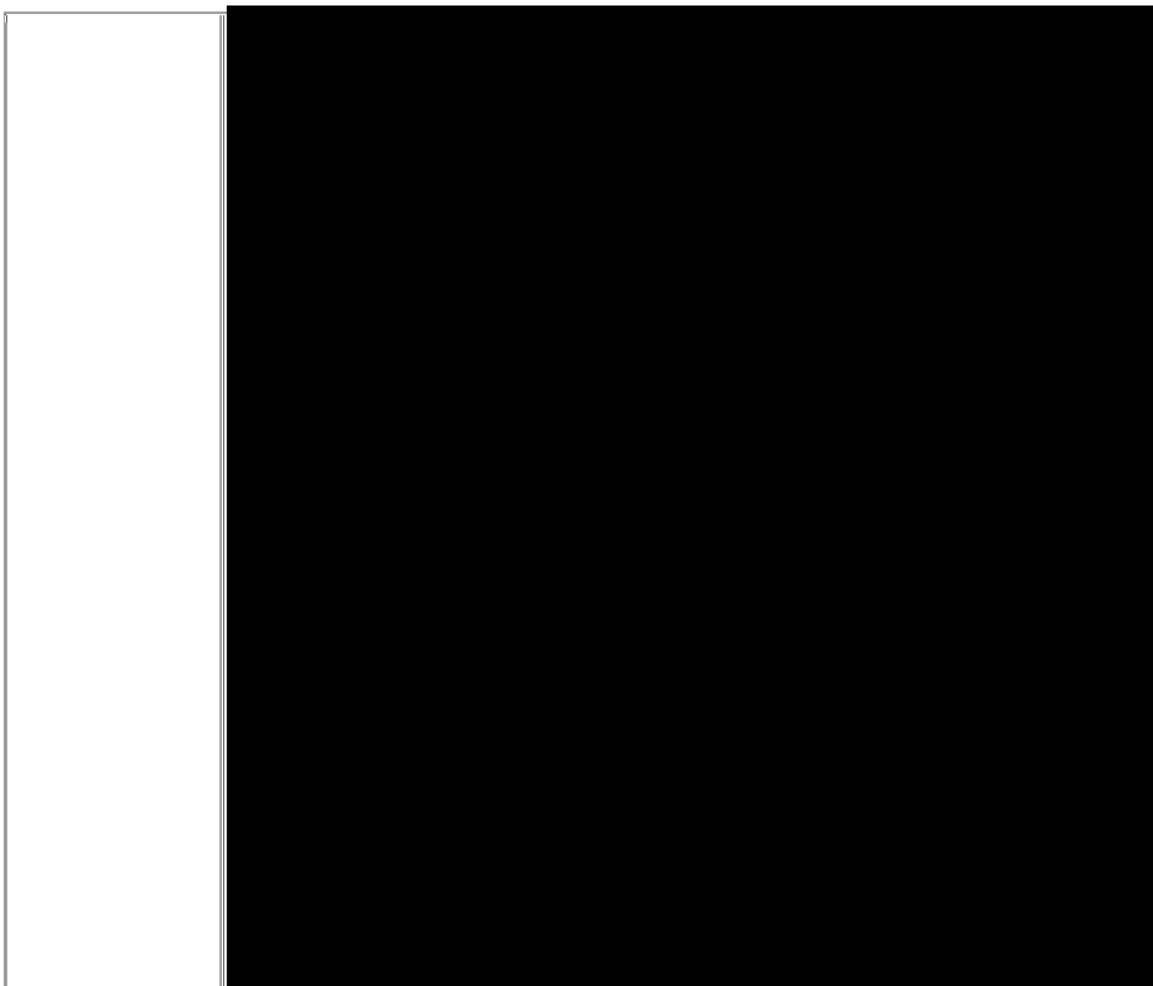


[16.d] generate and output a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at	

least some of
a plurality of
planar roof
sections of the
roof, wherein
the generated
roof estimate
report is
provided for
repair and/or
constructing
the roof
structure of
the building.



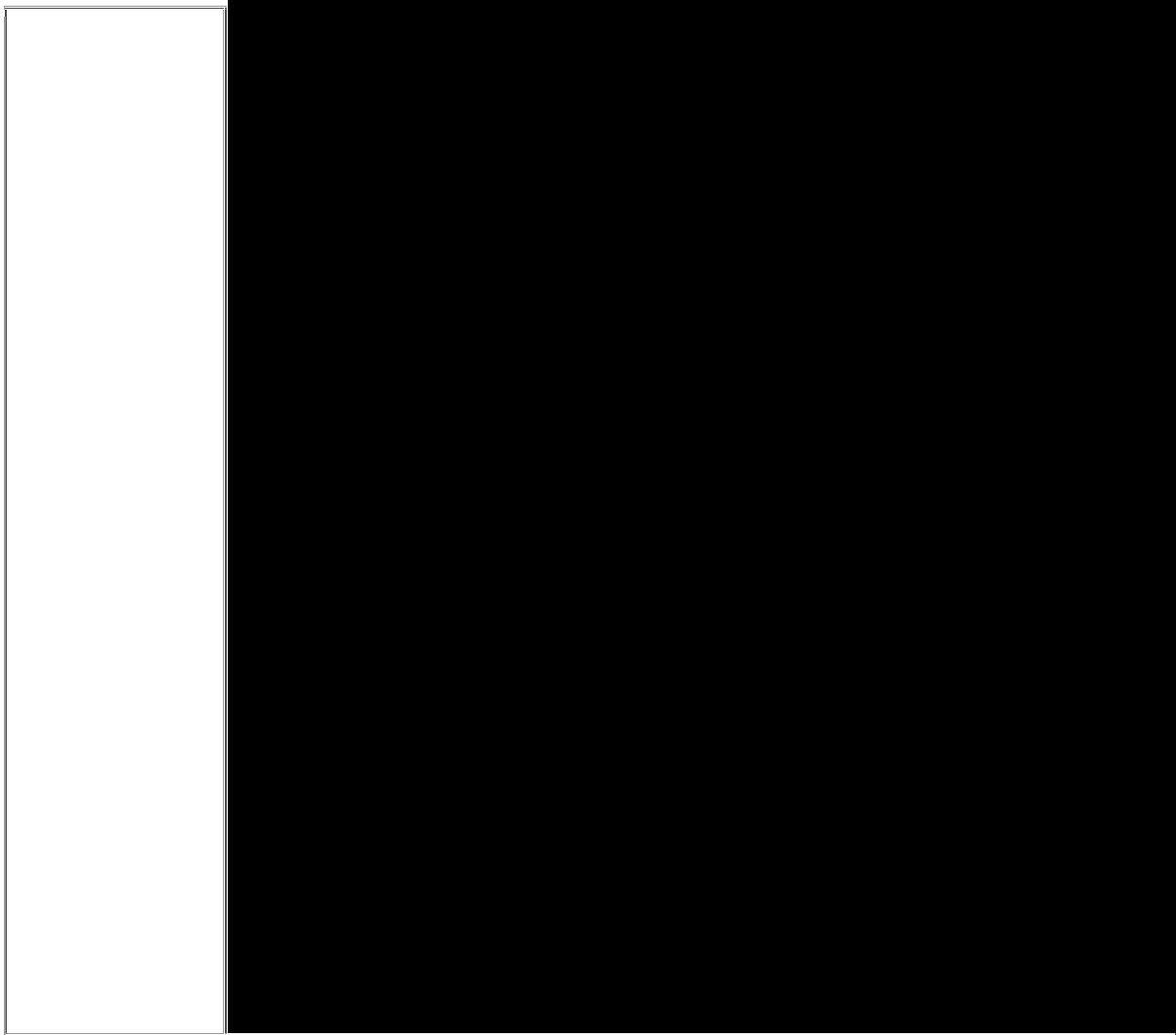




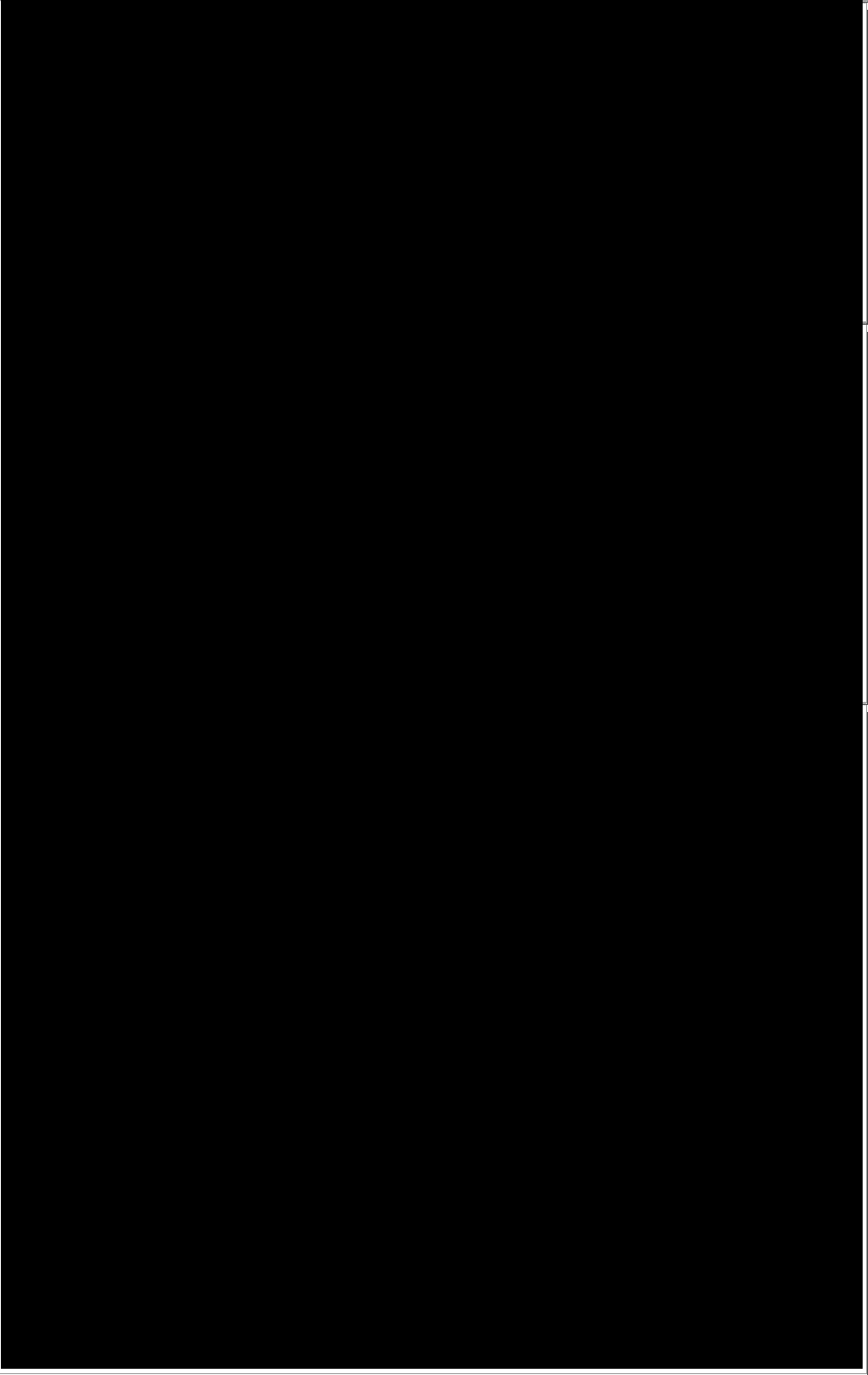


Claim 19 [19.a]: The non-transitory computer-readable storage medium of claim 16 further comprising: displaying the roof feature in the first aerial image at a first time; and	

[19.b] displaying the roof feature in the second aerial image at a second time that is within two seconds of the first time.	

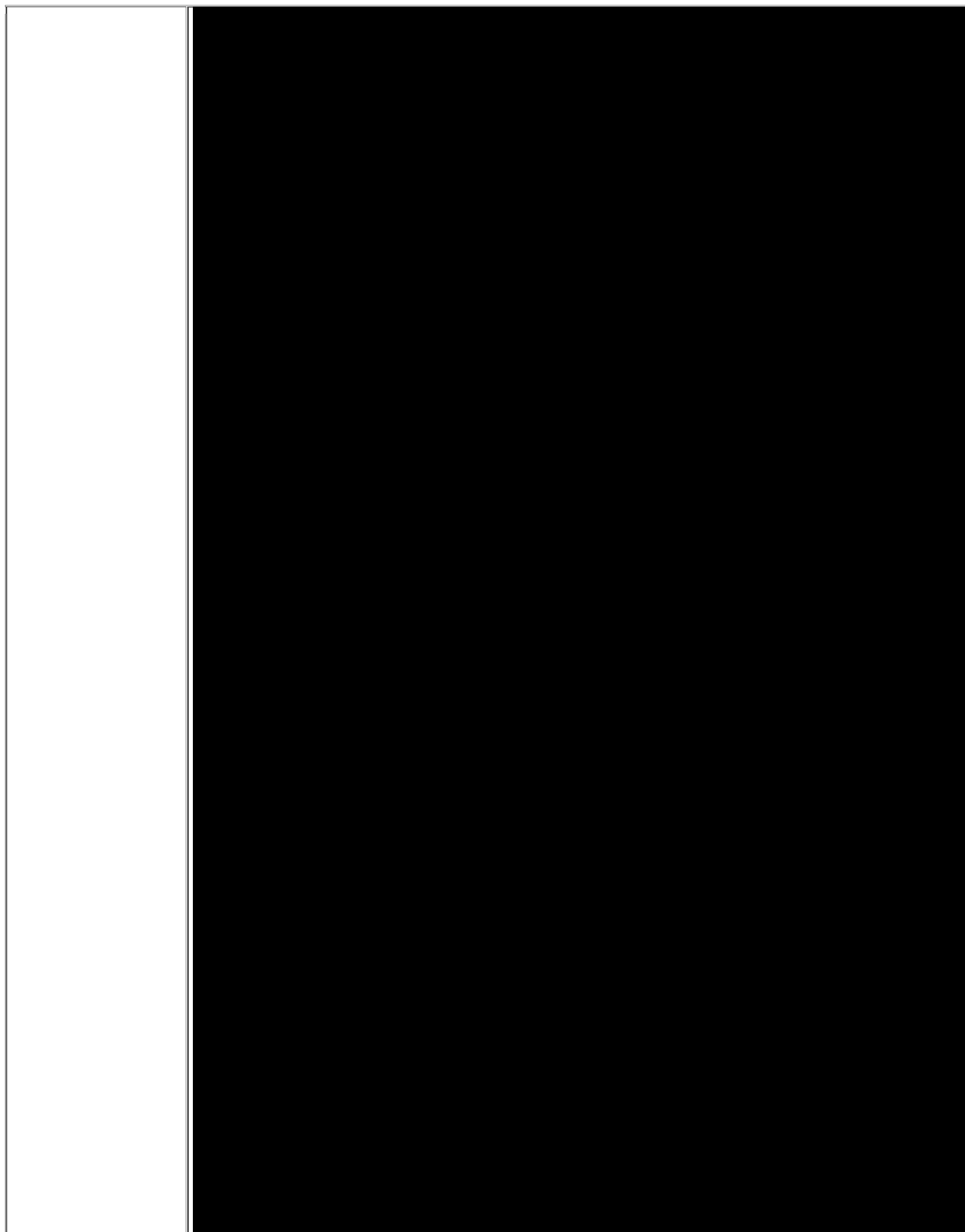


Claim 22
[22.a]: The non-transitory computer-readable storage medium of claim 16 wherein the method is performed iteratively, and the method further comprising:

	
[22.b] providing an operator with an interactive model generation experience.	
Claim 25: The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises: modifying a three dimensional model of the roof based at	

least on the
modification
of the line
drawing
overlaid on
the first aerial
image.

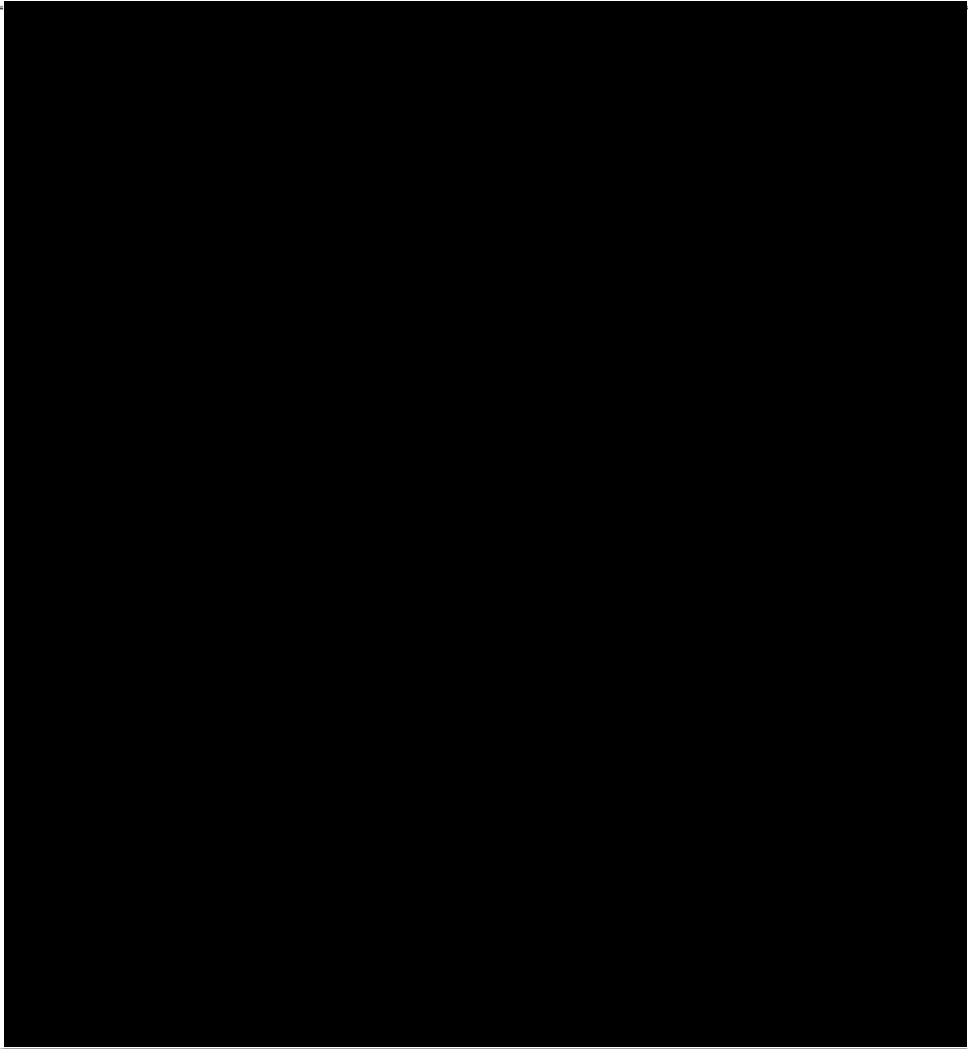


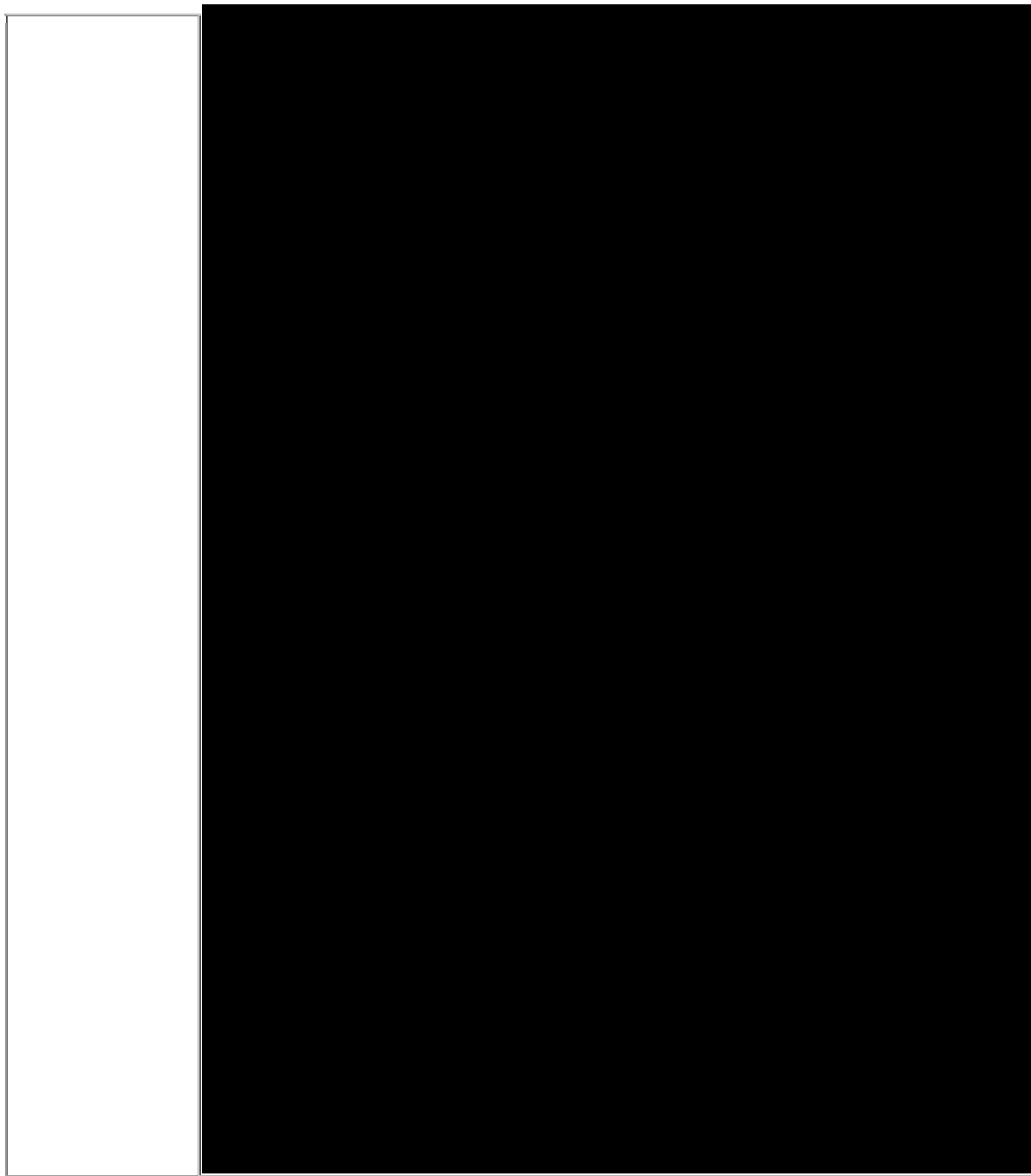


Claim 26
[26.a]: A computer-implemented method in a roof estimate report system including a computer system and a memory coupled to the computer system, the method comprising:

[26.b]
changing, by the computer system of the

roof estimate
report system,
a line in a first
line drawing
representing a
feature of a
roof that
overlies a first
aerial image
of the roof;

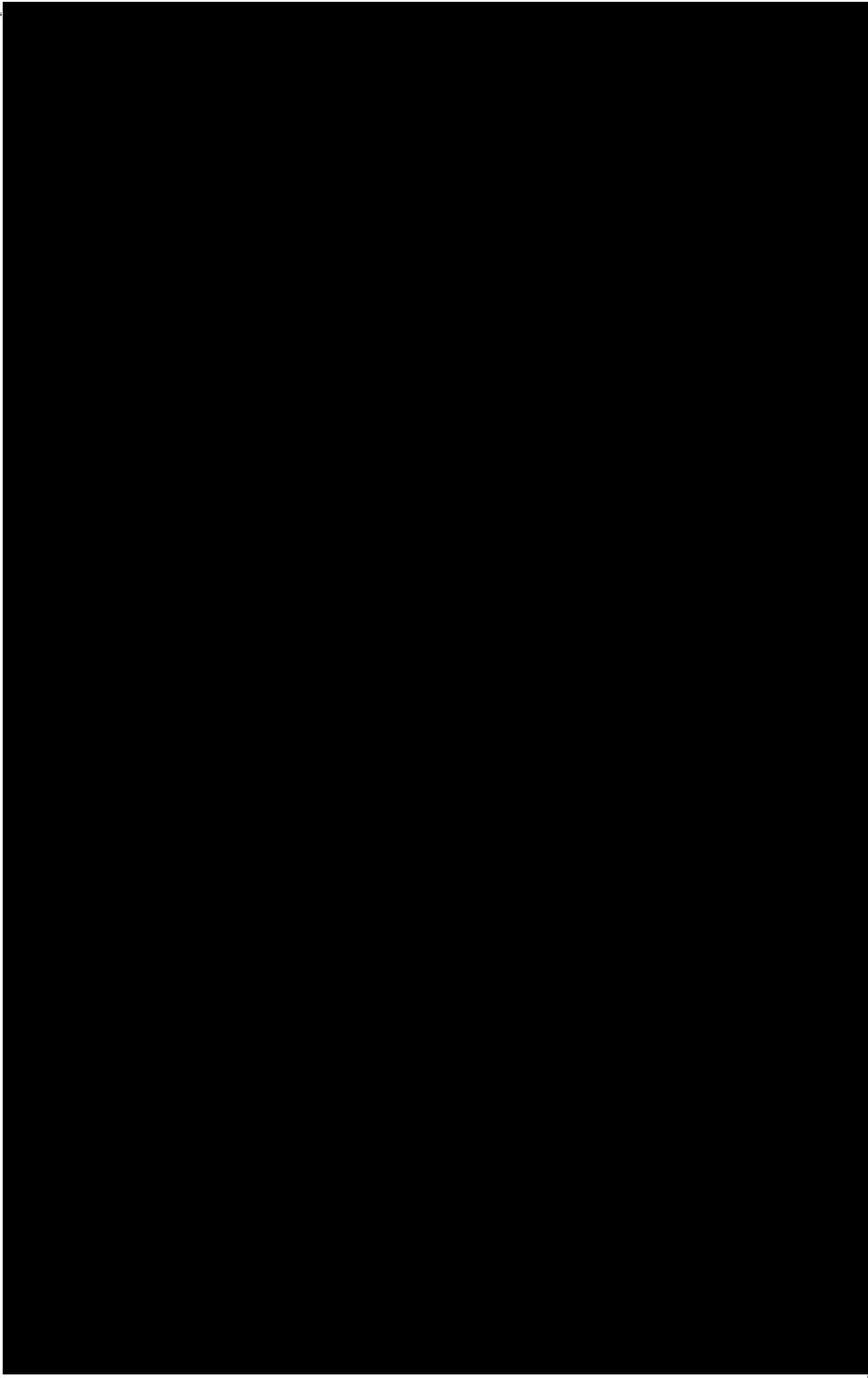






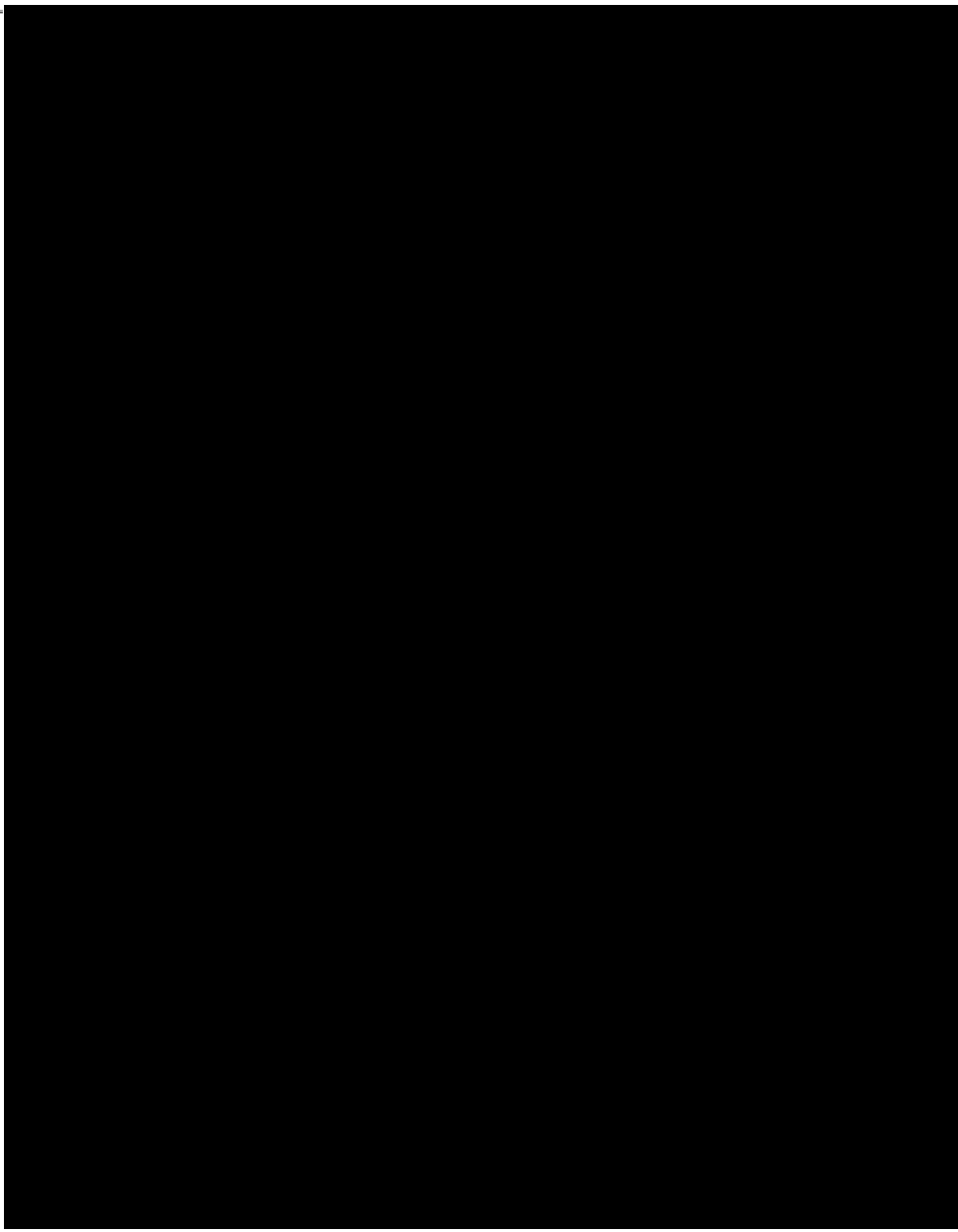
[26.c]

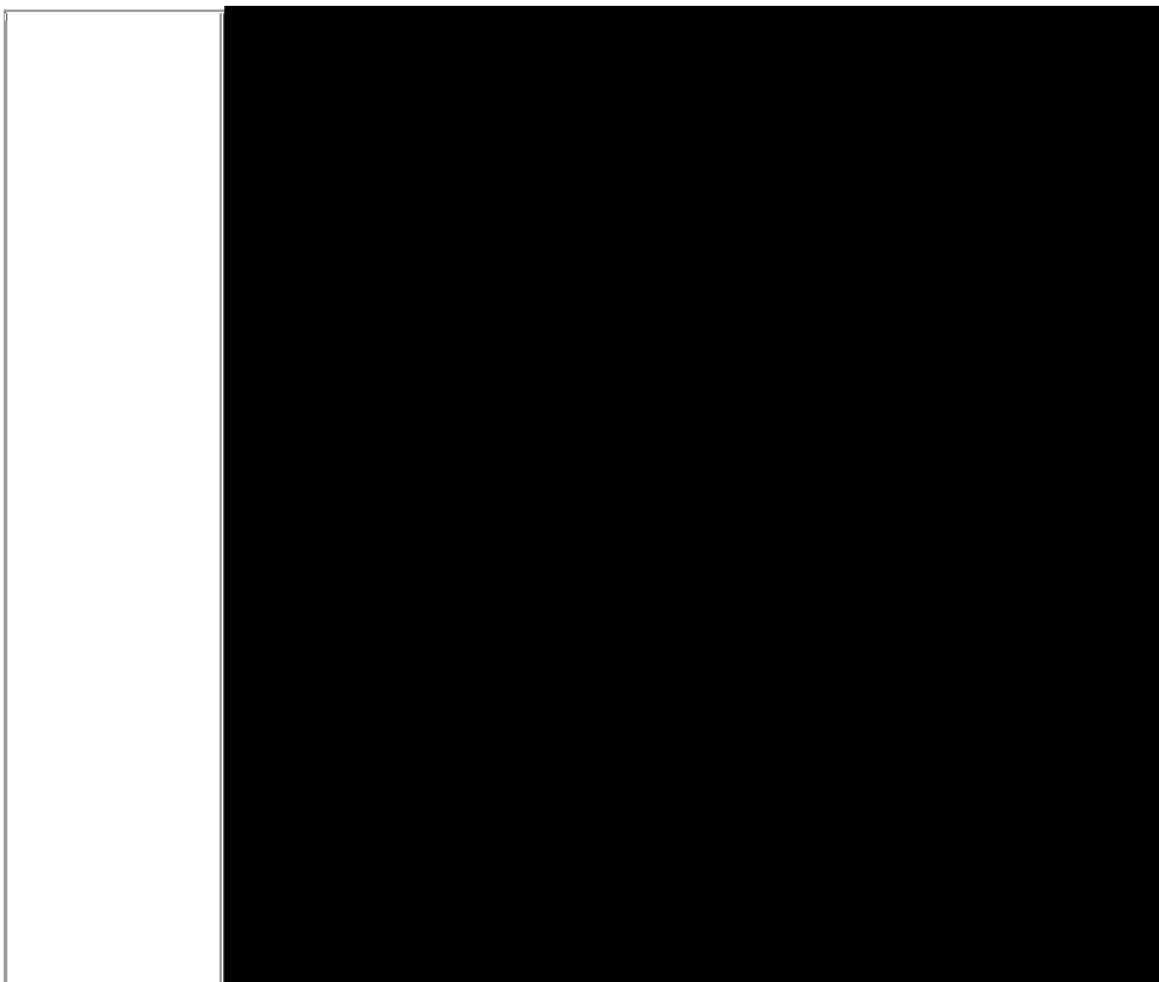
changing, by the computer system of the roof estimate report system, a line in a second line drawing that corresponds to the same feature in the first line drawing that was changed, the change in the second line drawing being made by the computer system in response to the change that was made in the first line drawing; and

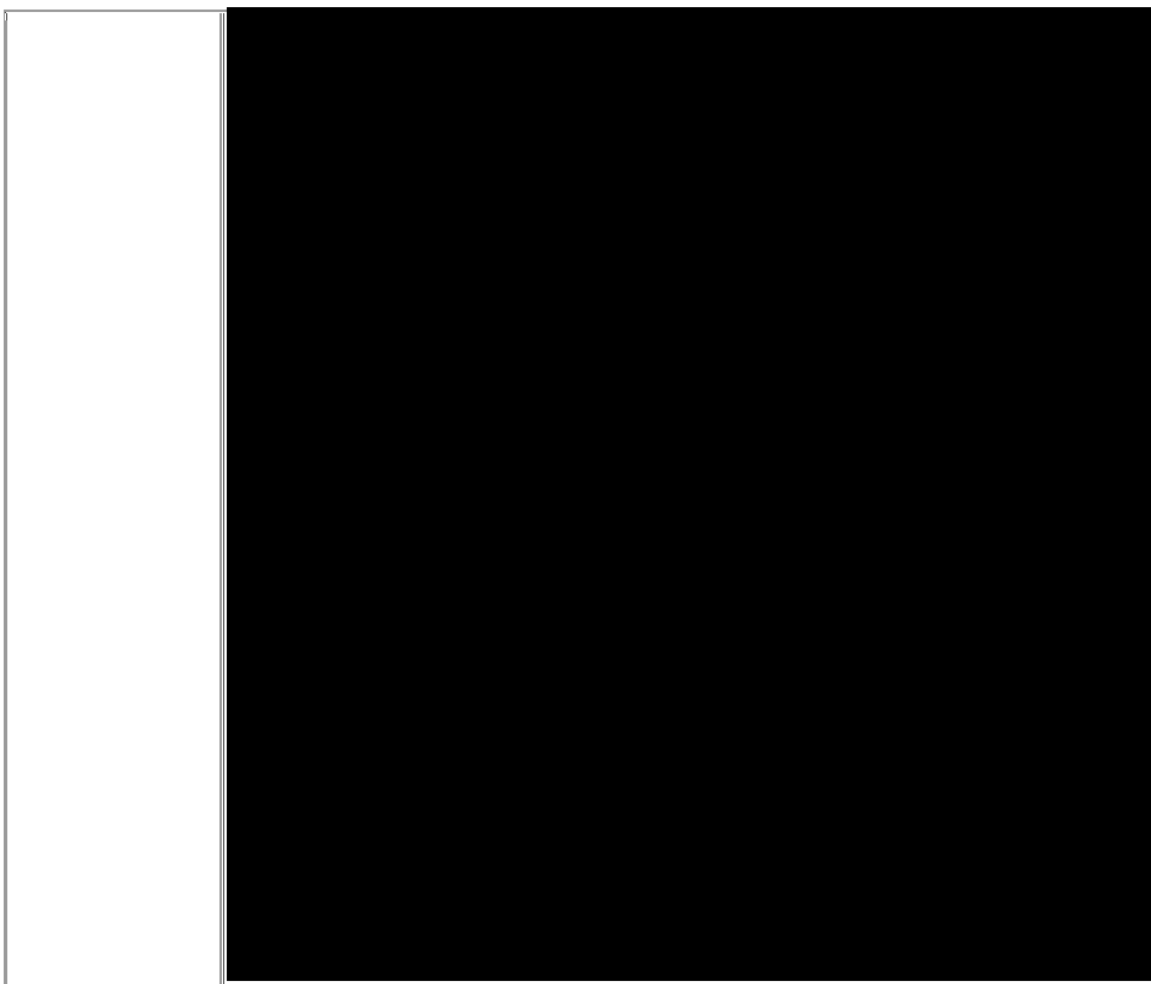


[26.d] generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for	

corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof, wherein the generated roof estimate report is provided for repair and/or constructing the roof structure of the building.





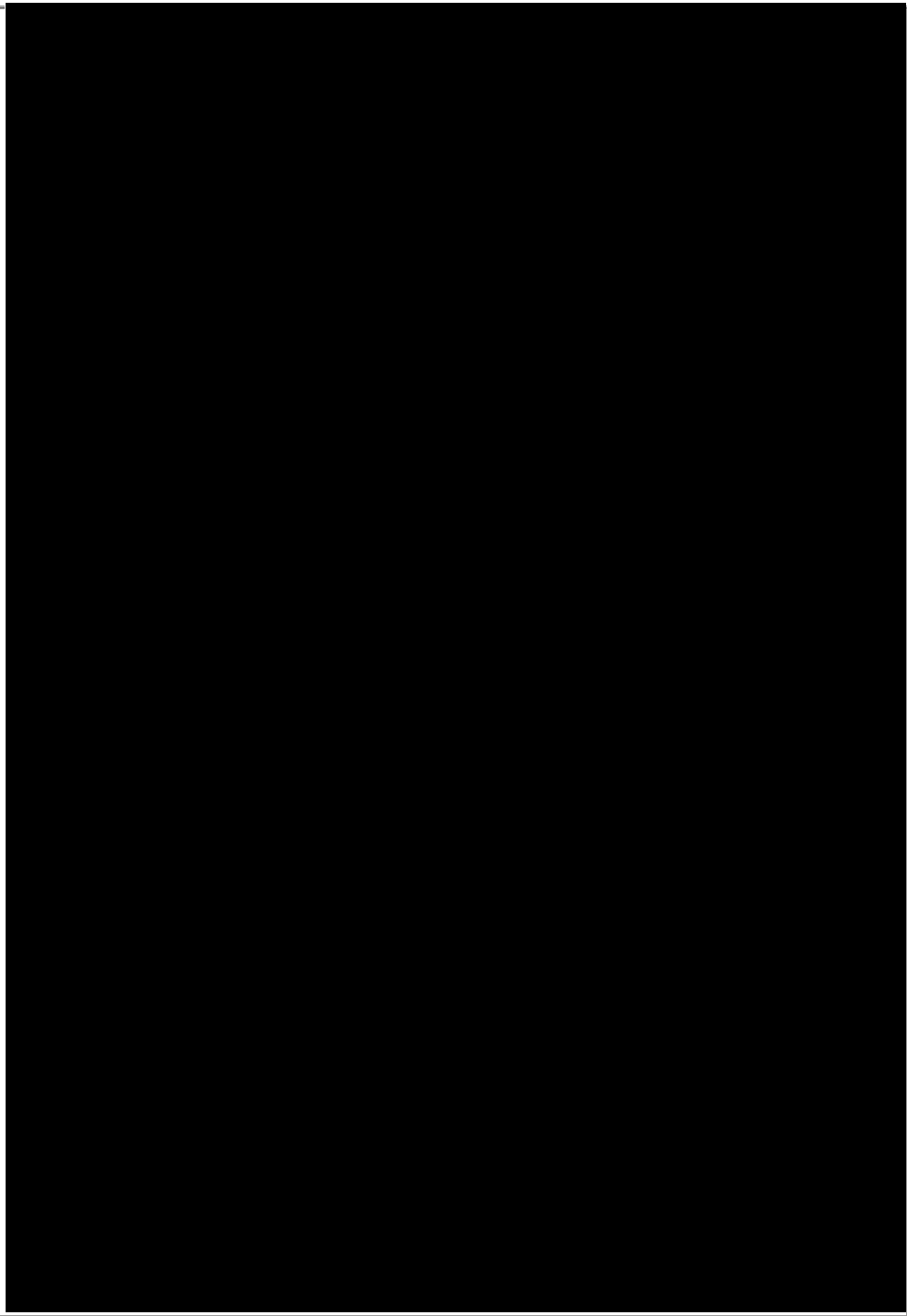


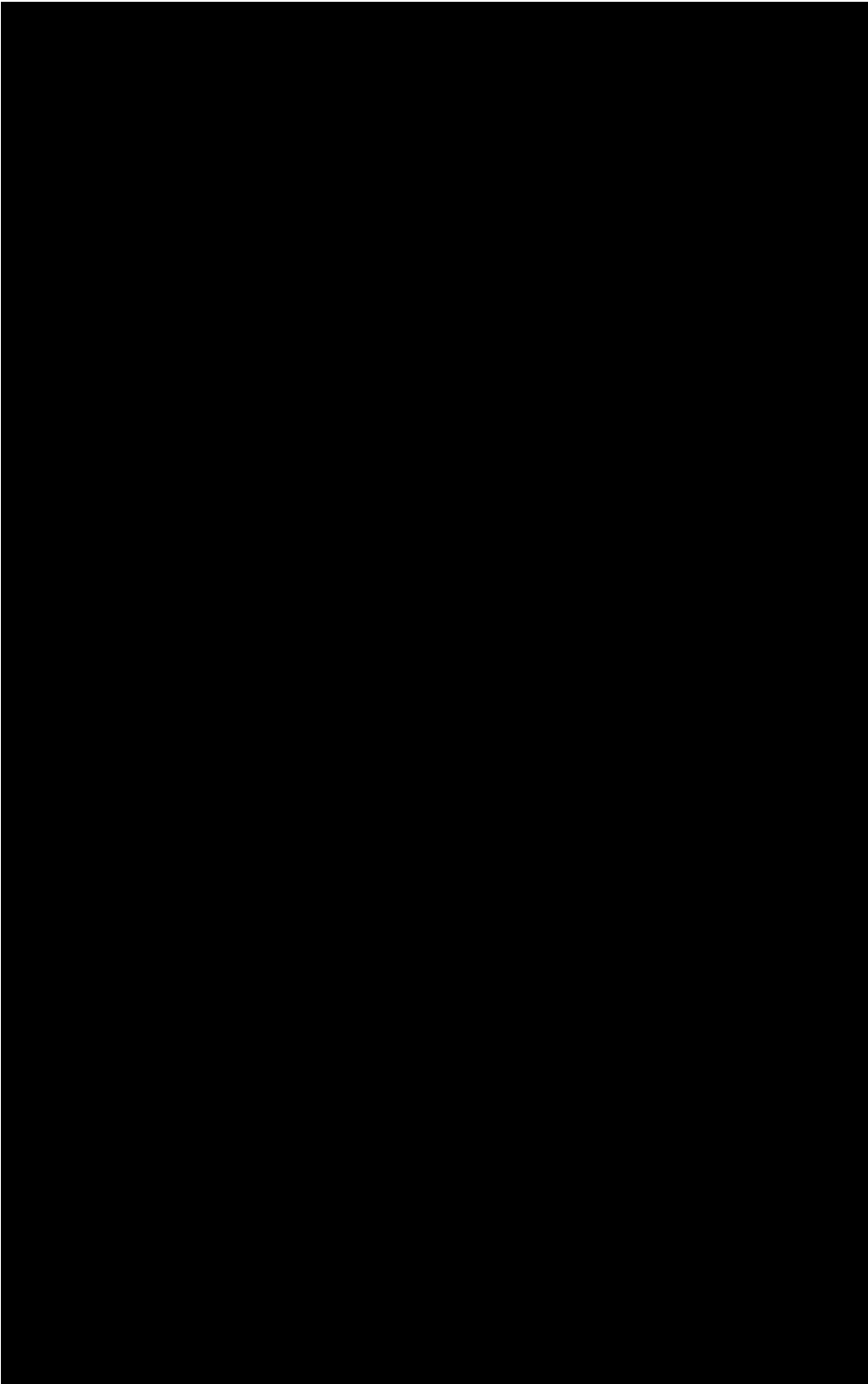


Claim 27:

The method
of claim 26
wherein the
roof feature is
at least one
of:

a ridgeline of
the roof, a
valley of the
roof, a rake
edge of the
roof, an eave
of the roof, a
hip ridge of
the roof, and
an edge of a
section of the
roof.



	
Claim 28: The method of claim 26 further comprising displaying the second line drawing after the first line drawing has been displayed.	
Claim 31: The method of claim 26	

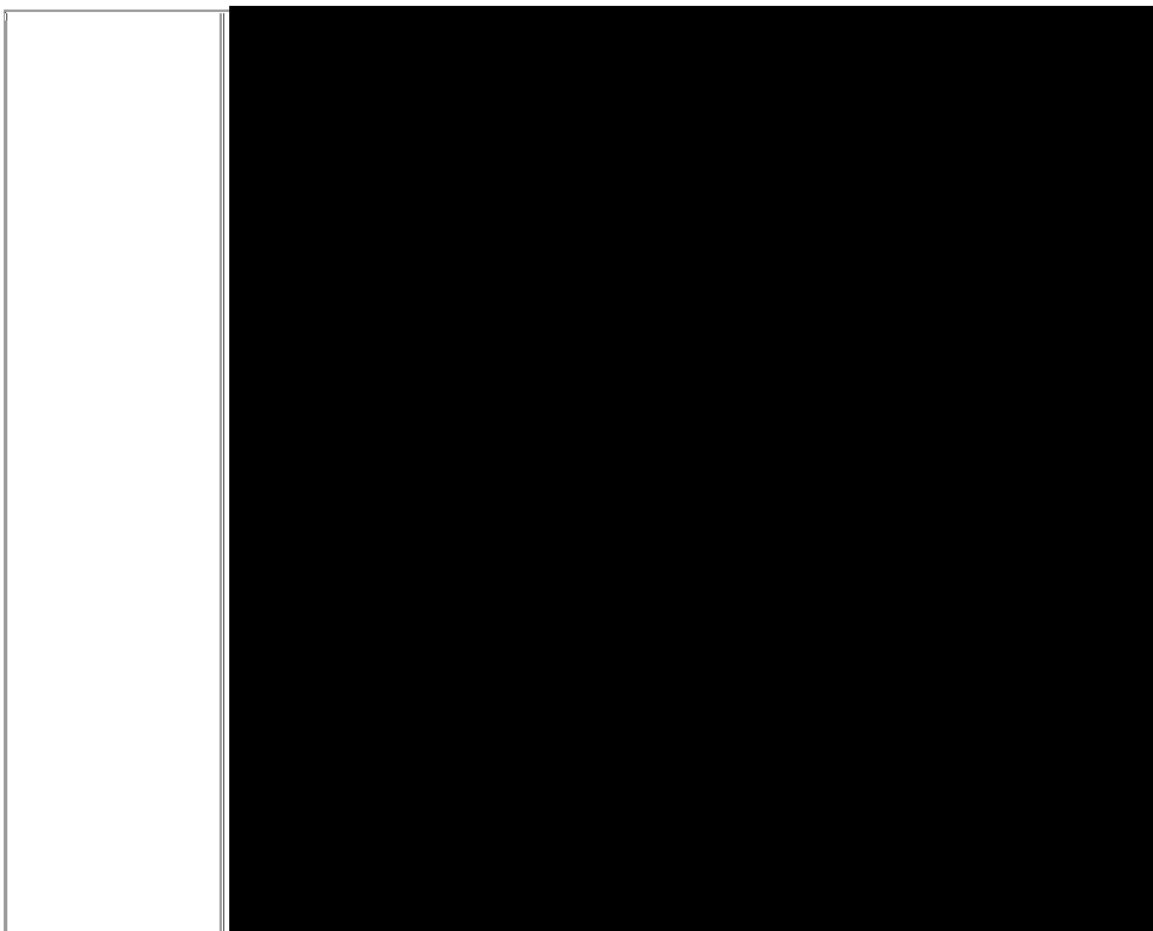
further
comprising:

displaying the
second line
drawing
overlying the
second aerial
image at a
later time,
after the
displaying of
the first line
drawing
overlying the
first aerial
image of the
roof on the
display.

Claim 34:

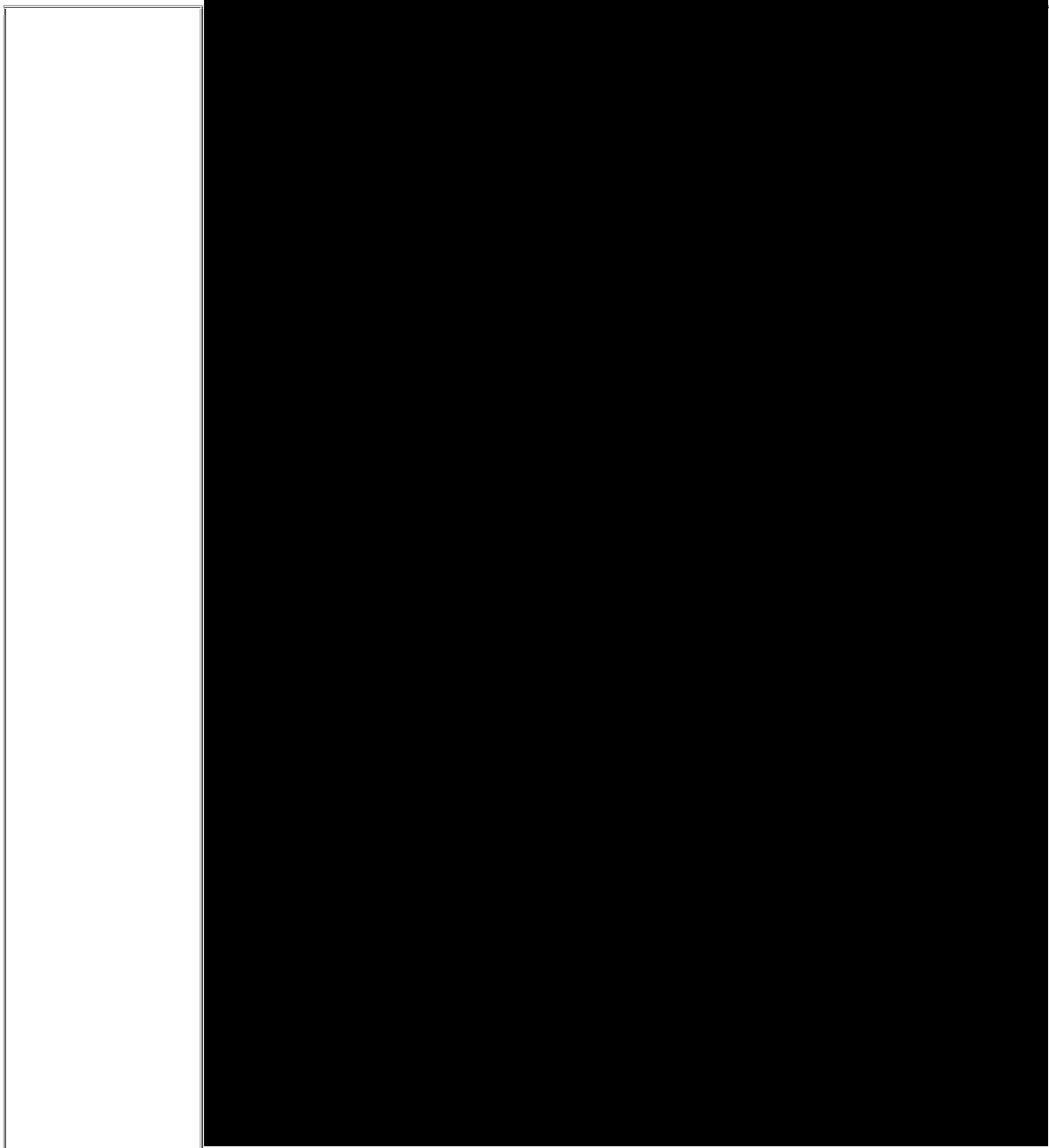
The method
of claim 26
further
comprising:

displaying
roof
measurement
information
on the same
display
concurrently
with the first
line drawing
being
displayed.





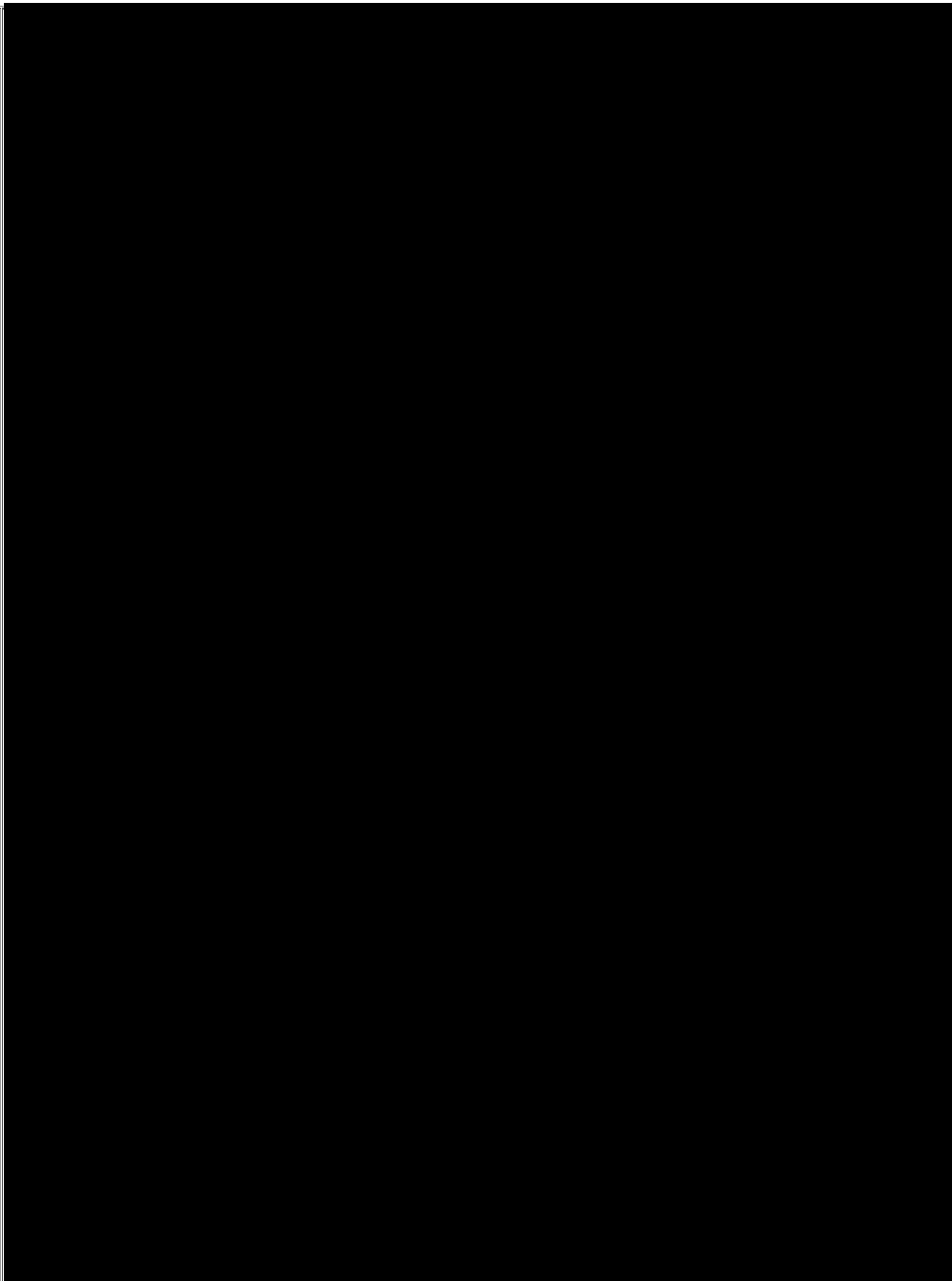
Claim 35: The method of claim 34 wherein the step of displaying roof measurement information comprises: displaying the roof measurement information in a location that overlays the first line drawing itself.	

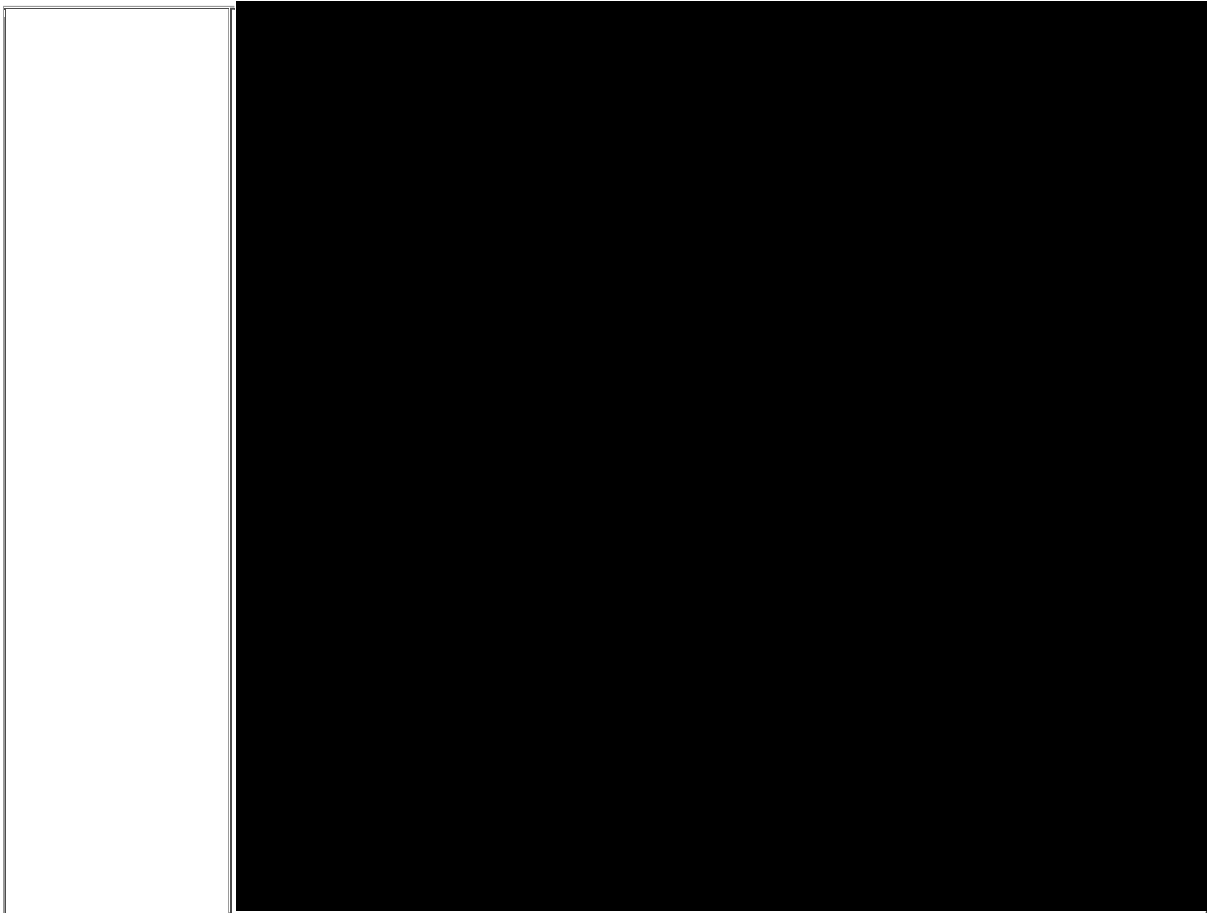


Claim 36:

The method
of claim 26
further
comprising:

displaying a
wire frame
model of the
roof in
isolation from
any images of
the roof.





IX. UNDERSTANDING OF PATENT LAW

85. I have been advised by counsel of the following legal standards, which I have applied to my analysis.

86. I understand that prior art to the '737 Patent includes patents and printed publications in the relevant art that predate the priority date of the inventions recited in the '737 patent. I understand that the earliest claimed priority

date for the '737 Patent is Provisional Application No. 61/197,904, filed on Oct. 31, 2008.

87. I understand that a claim is invalid if it is anticipated or obvious. Anticipation of a claim requires that every element of a claim be disclosed expressly or inherently in a single prior art reference, arranged in the prior art reference as arranged in the claim.

88. I further understand that the disclosure in an assertedly anticipating reference must provide an enabling disclosure of the desired subject matter; mere naming or description of the subject matter is insufficient if it cannot be produced without undue experimentation. I also understand that a disclosure is enabling if one of ordinary skill in the art could have combined the publication's description of the invention with his (or her) own knowledge to make the claimed invention.

89. Obviousness of a claim requires that the claim be obvious from the perspective of a person having ordinary skill in the relevant art at the time the alleged invention was made. I understand that a claim may be obvious from a combination of two or more prior art references.

90. For my obviousness analysis, I have been instructed to consider the following: (a) the scope and content of the prior art; (b) the differences between the prior art and the subject matter of the claimed invention; (c) the level of ordinary

skill in the art at the time of the claimed invention; (d) the real-world factors constituting objective indicia of non-obviousness such as long-felt need, failure of others to solve the problems addressed by each invention, initial skepticism, unexpected results, recognition in the industry, copying, and commercial success.

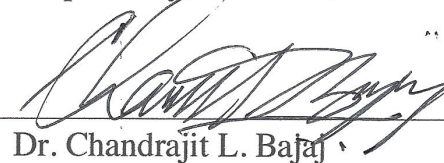
91. I have been informed that when determining invalidity for obviousness by combining prior art references, it is relevant whether a POSITA would have been motivated, taught, or suggested to combine the relevant teachings of the prior art and form the claimed invention. I have been informed that a POSITA is presumed to have had knowledge of analogous prior art in the field of invention. I have been informed that the motivation, teaching, or suggestion to combine prior art may come from the prior art itself, the knowledge of a POSITA, or from the nature of the problem to be solved. I also understand that it is not permissible to use hindsight in assessing whether the invention is invalid for obviousness. I understand that one should not look at the invention knowing what persons of ordinary skill in the art know today. Rather, you must place yourself in the shoes of a POSITA in the field of the technology of the patent at the time of the filing of the patent application.

92. I further understand that in an *inter partes* review a petitioner carries the burden of proof of showing unpatentability by a preponderance of the evidence.

I hereby declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct, and that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I understand that willful false statements and the like are punishable by fine or imprisonment or both. *See* 18 U.S.C. § 1001.

Dated: November 16, 2016

Respectfully submitted,



Dr. Chandrajit L. Bajaj