

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INTEL CORPORATION,
Petitioner,

v.

FUZZYSHARP TECHNOLOGIES, INC.,
Patent Owner.

Case IPR2014-00001
Patent 6,618,047 B1

Before JUSTIN T. ARBES, TREVOR M. JEFFERSON, and
DAVID C. MCKONE, *Administrative Patent Judges*.

MCKONE, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

A. Background

Intel Corporation (“Petitioner”) filed a Petition (Paper 1, “Pet.”) to institute an *inter partes* review of claims 1, 8, 11–13, 46, 57, 64, 65, and 67 of U.S. Patent No. 6,618,047 B1 (Ex. 1001, “the ’047 patent”). FuzzySharp Technologies, Inc. (“Patent Owner”) filed a Preliminary Response (Paper 6, “Prelim. Resp.”). Pursuant to 35 U.S.C. § 314, in our Decision to Institute (Paper 7, “Dec.”), we instituted this proceeding as to all of the challenged claims of the ’047 patent.

During this trial, Patent Owner filed a Patent Owner Response (Paper 15, “PO Resp.”) and Petitioner filed a Reply to the Patent Owner Response (Paper 19, “Reply”). An oral hearing in this matter and IPR2014-00002 (argued together) was held on October 28, 2014 (Paper 22, “Tr.”).

We have jurisdiction under 35 U.S.C. § 6(c). This decision is a final written decision under 35 U.S.C. § 318(a) as to the patentability of the challenged claims. Based on the record before us, Petitioner has demonstrated by a preponderance of the evidence that claims 1, 8, 11–13, 46, 57, 64, 65, and 67 are unpatentable.

B. Related Proceedings

According to Petitioner, Patent Owner has asserted the ’047 patent against Petitioner in Case No. 4:12-cv-04413-YGR (N.D. Cal.) (“Intel action”), which is currently on appeal to the U.S. Court of Appeals for the Federal Circuit. Pet. 2; Paper 18.

According to Patent Owner, the only matter pending that may be affected by a decision in this proceeding is *FuzzySharp Technologies, Inc. v. Nvidia Corp.*, Case No. 12-cv-6375-JST (N.D. Cal.). Paper 5, at 2.

Petitioner also filed a petition for *inter partes* review of U.S. Patent No. 6,172,679 B1 (“the ’679 patent”). See *Intel Corp. v. FuzzySharp Technologies, Inc.*, Case IPR2014-00002 (PTAB). The ’047 patent is a continuation of the ’679 patent. See Ex. 1001, at [63]. The ’679 patent also is asserted by Patent Owner in the Intel action. See, *e.g.*, Ex. 1009.

C. References Relied Upon

Petitioner relies upon the following prior art references:

David Salesin & Jorge Stolfi, *The ZZ-Buffer: A Simple and Efficient Rendering Algorithm with Reliable Antialiasing* (1989) (Ex. 1002, “Salesin”);

JAMES D. FOLEY ET AL., *COMPUTER GRAPHICS, PRINCIPLES AND PRACTICE* 340–41, 521–22, 665, 799 (2d ed. 1990) (Ex. 1003, “Foley”).

D. Grounds of Unpatentability

We instituted this proceeding based on the grounds of unpatentability set forth in the table below. Dec. 36–37.

Reference(s)	Basis	Claim(s) Challenged
Salesin	§ 102(b)	1, 8, 12, 13, 46, 57, 64, 65, and 67
Salesin and Foley	§ 103(a)	11

E. The '047 Patent

The '047 patent describes techniques for improving three-dimensional (“3-D”) computer graphics visibility calculations. Ex. 1001, 1:13–16. A point in a 3-D image can be viewed from multiple viewpoints. *Id.* at 4:14–24. This is illustrated in Figures 2 and 3, reproduced below:

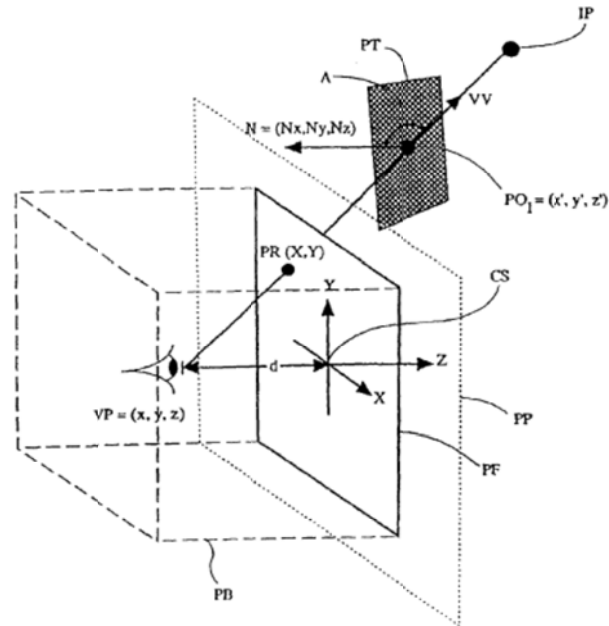


FIG. 2

Figure 2 depicts projections of a point at an arbitrary viewpoint. *Id.* at 3:13.

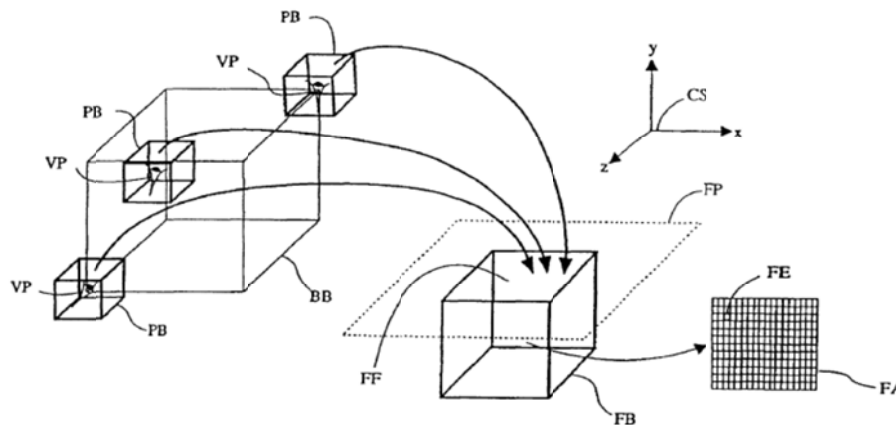


FIG. 3

Figure 3 depicts the relationship between projection boxes and a fuzzy projection box. *Id.* at 3:14–15.

A group of viewpoints (e.g., the three VPs of Figure 3) can be associated with a coordinate system and grouped in a “viewpoint bounding box” (e.g., BB of Figure 3), which the patent describes as the smallest right quadrangular prism enclosing the viewpoints. *Id.* at 4:35–40. The point to be observed can be said to be totally visible from the bounding box if it is always visible from every possible viewpoint in the bounding box and totally invisible if it is hidden from every such viewpoint. *Id.* at 4:46–50. The group of viewpoints may contain only a single viewpoint; in that case, the bounding box degenerates into the viewpoint. *Id.* at 4:58–63.

As shown in Figure 2, the point to be observed (PO) can be represented by the intersection of a projection plane (PP) and a vector (VV) from the point to be observed (PO) to a viewpoint (VP). *Id.* at 5:3–16; Fig. 2. As shown in Figure 3, to facilitate sampling, the projection plane can be divided into rectangular cells or elements (fuzzy array FA). *Id.* at 6:27–

36. As shown in Figure 2, the point may be included in a visible patch (PT) that occludes an invisible point (IP). *Id.* at 5:18–20. Surfaces can be approximated by meshes of patches and also by hierarchies that represent meshes of patches at different levels of detail. *Id.* at 6:43–46. The smallest right quadrangular prism that encloses a patch and whose edges are parallel to the coordinate system is termed a “bounding volume” of the patch. *Id.* at 6:54–57.

The '047 patent describes detecting patches that are invisible to all viewpoints in a bounding box. *Id.* at 8:42–10:21. Similarly, it describes detecting patches that are totally visible to all viewpoints in the bounding box. *Id.* at 10:22–11:16. Overlapping patches can be stored in a linked list called a projection patch list. *Id.* at 11:20–25. The '047 patent describes calculating a list of the totally visible and totally invisible patches for a viewpoint group. *Id.* at 11:20–12:57. The patches identified as totally visible and totally invisible can be ignored in subsequent visibility computations. *Id.* at 12:57–67. For example, they need not be compared with other patches to determine their visibility. *Id.* at 12:62–64.

Claims 11 and 67, reproduced below, are illustrative of the claimed subject matter:

11. A method of reducing a step of visibility computations in 3-D computer graphics from a perspective of a viewpoint, the method comprising:

computing, before said step and from said perspective, the visibility of at least one entity selected from 3-D surfaces and sub-elements of said 3-D surfaces, wherein said computing step comprises at least a comparison between a pair of depth-related numbers to determine which of the surfaces or the

sub-elements of the surfaces associated with said numbers is closer to said viewpoint and said 3-D surfaces are arranged in a hierarchy represented by patches in varying levels of details; and

skipping, at said step, at least an occlusion relationship calculation for at least one entity that has been determined to be invisible in said computing step.

67. A method in 3-D computer graphics for processing the visibility of 3-D surfaces before a subsequent step of visibility computations, said method comprising:

for each selected 3-D surface or sub-element of a 3-D surface, identifying grid cells on a projection plane which are under or related to a projection associated with the bounding volume of said selected 3-D surface or sub-element, said projection and said subsequent step of visibility computations are from the perspective of a same viewpoint;

for each of said grid cells, accessing the corresponding z-buffer element; and

computing the visibility of the part of the bounding volume that projects onto said each of said grid cells by comparing the depth-related data stored in said corresponding z-buffer element with the depth-related value associated with said part.

II. ANALYSIS

A. Claim Construction

The '047 patent is expired. “[T]he Board’s review of the claims of an expired patent is similar to that of a district court’s review.” *In re Rambus Inc.*, 694 F.3d 42, 46 (Fed. Cir. 2012) (internal citations omitted). Thus, we

construe the claims in accordance with their ordinary and customary meanings, as would be understood by a person of ordinary skill in the art, in the context of the specification. *See generally Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc).

In the Petition, Petitioner asserted that the parties had stipulated to the constructions of several claim terms in the Intel action. Pet. 14–17. Patent Owner did not propose a construction for any claim term in the Preliminary Response. For several claim terms, we preliminarily determined that the purportedly stipulated constructions proposed by Petitioner represented the ordinary and customary meaning of those terms, as would be understood by a person of ordinary skill in the art, in the context of the specification. Dec. 9–11. For other claim terms, we determined the purportedly stipulated constructions proposed by Petitioner were too narrow. *Id.* at 11–13.

Additionally, Petitioner proposed a construction for “determining which of said at least one of 3-D surfaces or their sub-elements is always invisible or always visible,” as recited in claims 1 and 8, that would require determining which of the at least one of 3-D surfaces is *either* always invisible or always visible. Pet. 12–14; Dec. 15. We declined to adopt this construction and preliminarily determined that the term requires determining which of the at least one of the 3-D surfaces or their sub-elements is always invisible or determining which of the at least one of the 3-D surfaces or their sub-elements is always visible. Dec. 16.

In sum, we preliminarily construed the claim terms of the ’047 patent as follows:

Claim Term	Construction
“visibility related computations” (claims 1, 8, 64) “visibility computation(s)” (all challenged claims) “occlusion relationship calculation” (claims 11–13, 46)	prior art types of rendering computations that determine which pixels or groups of pixels of 3-D surface(s) are visible, which include z-buffering and other visibility tests performed during rendering
“reducing the visibility related computations” (claims 1, 8, 64)	decreasing the number of computational operations to perform visibility computations
“3-D surfaces” (all challenged claims) “surfaces” (all challenged claims) “sub-elements” (all challenged claims)	surfaces (i.e., the exterior) of 3-D objects that are part of a scene
“identifying grid cells” (claims 1, 8, 64, 65, 67) “identifying, from said perspective, grid cells” (claim 57)	dividing a projection plane into an imaginary lattice structure, where a “grid” is an “imaginary lattice structure”
“regular” grid cells (claim 57)	identical rectangular grid cells
“projection(s)” (all challenged claims except claim 11) “extent(s) of projection(s)/projection region(s)” (claims 64, 65) “projection plane” (claims 8, 12, 13, 46, 57, 65, 67) “projections or extents” (claims 1, 8, 56, 64)	representation(s) of a 3-D object’s surfaces upon an imaginary plane
“viewpoint” (all challenged claims)	the spatial position and orientation of a viewer

Claim Term	Construction
“always invisible” (claims 1, 8) “always visible” (claims 1, 8) “invisible” (claims 11, 12, 57, 64) “visible” (claim 46)	totally invisible/visible from a single viewpoint (if a single viewpoint) or totally invisible/visible from every viewpoint (if from a group of viewpoints)
“z-buffer” (claims 57, 65, 67)	a data structure in memory that is used to store depth data
“bounding volume” (claims 12, 13, 46, 57, 64, 67)	the smallest imaginary right quadrangular prism just enclosing the 3-D object’s surfaces and whose edges are parallel to the axes of the group coordinate system that approximates the 3-D object’s surfaces
“identifying regions on . . . projection plane(s)” (claims 8, 12, 13, 46)	(does not require express construction)
“largest depths of said 3-D surfaces or their sub-elements” (claim 8)	largest distances from a viewpoint to the 3-D surfaces or their sub-elements along the z-axis
“depth-related” (claims 11, 65, 67)	related to the distance from a viewpoint to a 3-D surface along the z-axis
“projection based computations” (claim 1)	computations that are based on representation(s) of a 3-D object’s surfaces upon an imaginary plane or planes
“determining which of said at least one of 3-D surfaces or their sub-elements is always invisible or always visible” (claims 1, 8)	determining which of the at least one of the 3-D surfaces or their sub-elements is always invisible or determining which of the at least one of the 3-D surfaces or their sub-elements is always visible

Petitioner and Patent Owner do not dispute these constructions. We see no reason to change these constructions based on the complete record developed during this trial and, thus, maintain them for purposes of this Decision. Neither Petitioner nor Patent Owner identifies any additional terms requiring construction. We also do not identify any other terms that require express construction for purposes of this Decision.

B. Asserted Grounds of Unpatentability

1. Anticipation by Salesin

a. Salesin

Salesin describes an improved algorithm for rendering 3-D images. Ex. 1002, p. 1, cols. 1–2.¹ According to this algorithm, a screen plane is divided into a two-dimensional array of rectangular cells (in “x” and “y” directions of a coordinate system), each of which covers a fixed-sized block of pixels. *Id.* at p. 2, col. 1. This array is represented in memory by a “ZZ-buffer,” which is a two-dimensional array. *Id.* Figure 1, reproduced below, illustrates an example:

¹ Citations to Exhibit 1002 are in the form of page number of the article and column number on the page (p. x, col. y).

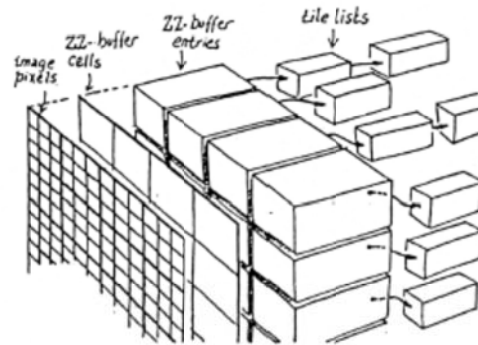


Figure 1. The ZZ-buffer.

Figure 1 illustrates a ZZ-buffer. Each ZZ-buffer entry includes a pointer to a “tilelist,” or linked list of tiles, and each tile describes an object that may be visible within the ZZ-buffer cell. *Id.* at p. 2, col. 2. Figure 2, reproduced below, illustrates Salesin’s tiles:

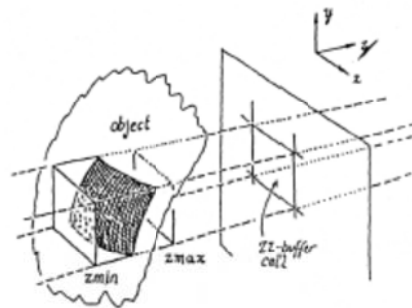


Figure 2. Tiles.

Figure 2 illustrates the representation of a tile in a tilelist. Each tile includes minimum and maximum depths (Z_{min} and Z_{max} , respectively, in a “z” direction of the coordinate system) spanned by the object in the tile relative to the screen plane. *Id.* Each tile also has a field indicating whether its object is opaque and covers the cell entirely. *Id.*

During a “scan conversion” phase, tiles can be added to the tilelists of the cells. *Id.* at p. 3, col. 1. During the tile adding procedure, a quick visibility test is performed on a new tile based on its depth and opacity information, and the tile is thrown away if it is obscured completely by other tiles already in the tilelist. *Id.* at p. 2, col. 2–p. 3, col. 1. Similarly, if the new tile completely obscures other tiles in the tilelist, those other tiles are discarded. *Id.* at p. 3, col. 1.

Salesin describes a “rendering” phase, performed after the scan conversion phase, during which the visibility of objects is further calculated, and visible objects are shaded. *Id.* at p. 3, cols. 1–2. According to Salesin, if the first object in a tilelist is opaque and covers the entire cell, then no visibility tests are performed for that cell. *Id.* at p. 12, cols. 1–2.

b. Claims 1, 8, 12, 13, 46, 57, 64, and 65

Petitioner introduced, in the Petition, evidence that claims 1, 8, 12, 13, 46, 57, 64, and 65 are anticipated by Salesin. Pet. 23–35. Petitioner’s evidence included the declaration testimony of Dr. Seth Teller, a professor in the Electrical Engineering and Computer Science department of the Massachusetts Institute of Technology. *See id.* (citing Ex. 1013 (“Teller Decl.”) ¶¶ 56, 102, 109, 110, 114–116).² Based on the evidence presented in the Petition, we preliminarily determined that Petitioner established a reasonable likelihood of prevailing in showing that claims 1, 8, 12, 13, 46, 57, 64, and 65 are anticipated by Salesin. Dec. 17–29.

² The Petition cites to Exhibit 1008. Petitioner, however, filed Exhibit 1013 correcting Exhibit 1008. *See* Paper 9, at 2–3; Paper 11, at 1–2.

The PO Response is silent as to these claims and does not present any argument or evidence to show that they are patentable. Patent Owner also did not present any argument or evidence as to the patentability of these claims in its Preliminary Response. We have reviewed the Petition (at 23–27, 31–35) and evidence cited therein (including Teller Decl., Ex. 1013 ¶¶ 56, 102, 109, 110, 114–16), and are persuaded, by a preponderance of the evidence, that claims 1, 8, 12, 13, 46, 57, 64, and 65 are unpatentable based on anticipation by Salesin. *Cf. Corning Inc. v. DSM IP Assets B.V.*, Case IPR2013-00046, slip op. at 4–5 (PTAB May 1, 2014) (Paper 81, Final Written Decision) (concluding that the challenged claims were unpatentable where the patent owner provided no additional substantive arguments in its patent owner response).

c. Claim 67

Petitioner contends that Salesin anticipates claim 67. Pet. 35. Petitioner and Patent Owner dispute whether Salesin discloses the “bounding volume” recited in claim 67. We are persuaded that a preponderance of the evidence shows that Salesin does disclose the recited bounding volume, as well as the remaining limitations of claim 67.

Independent claim 67 (emphases added) recites, *inter alia*:

for each selected 3-D surface or sub-element of a 3-D surface,
identifying grid cells on a projection plane which are
under or related to a projection *associated with the*
bounding volume of said selected 3-D surface or sub-
element . . . [and]

computing the visibility of the part of *the bounding volume* that
projects onto said each of said grid cells by comparing
the depth-related data stored in said corresponding z-

buffer element with the depth-related value associated with said part.

Petitioner contends that Salesin meets these claim limitations because Salesin describes performing its pre-rendering scan conversion phase on what amounts to a bounding volume. Pet. 32–33.³ Per our construction in Section II.A above, a “bounding volume” for a 3-D object is the smallest imaginary right quadrangular prism just enclosing the 3-D object’s surfaces and whose edges are parallel to the axes of the group coordinate system that approximates the 3-D object’s surfaces.

As explained above, Salesin describes a ZZ-buffer that includes a two-dimensional array of rectangular cells (represented in x and y directions of a coordinate system), each of which contains a field pointing to a linked list of tiles that are defined, in part, with *zmin* and *zmax* fields (which delineate boundaries in a z direction of the coordinate system). Ex. 1002, p. 2, cols. 1–2. Petitioner contends that Salesin discloses a bounding volume consisting of a number of cells in the xy plane along with depth dimensions of the tiles for those cells. Specifically, Petitioner points to Salesin’s description of classifying polygons to be rendered, where Salesin explains that it “consider[s] a polygon small if its xy-bounding box does not span more than a few cells (say, 5 or 6) in each dimension.” Ex. 1002, p. 4, col. 1. According to Petitioner, the xy extent of the polygon’s bounding box, along with the *zmin* and *zmax* fields for the cells of the bounding box,

³ As explained in the Decision to Institute, at 23, claim 12 recites a bounding volume in the alternative and, thus, does not require a bounding volume. Petitioner, however, provides its analysis of bounding volumes in conjunction with claim 12 and incorporates its analysis of claim 12 for claim 67. Pet. 35.

constitutes a bounding volume. Pet. 32. Petitioner contends that Salesin describes performing its pre-rendering scan conversion phase on this 3-D volume bounded by *zmin*, *zmax*, and the xy extent of the cells of the polygon. *Id.* at 32–33. Petitioner supports its arguments with the testimony of Dr. Teller. Ex. 1013 ¶ 114.

Patent Owner responds that the cells of Salesin’s ZZ-buffer are described specifically as two-dimensional cells in a screen plane and, thus, cannot constitute three-dimensional volumes. PO Resp. 2. As explained above, however, Petitioner is not relying on the xy extent of a polygon in grid cells alone. Rather, as Petitioner points out, Salesin describes performing scan conversion on volumes that also include *zmin* and *zmax* dimensions. For example, Salesin explains that, during scan conversion, “we take each object, compute a rough [*zmin*, *zmax*] interval for every cell that may contain some part of the object, and store the resulting tiles into the ZZ-buffer.” Ex. 1002, p. 3, col. 1. Thus, we are not persuaded by Patent Owner’s argument.

Patent Owner also argues that, assuming Salesin shows 3-D volumes, Salesin’s cells are defined arbitrarily as having the same dimensions and, thus, do not constitute the smallest imaginary right quadrangular prism that encompasses an object. PO Resp. 2. Patent Owner, however, does not explain why a bounding volume must be evaluated at a level of granularity finer than Salesin’s grid cell. Indeed, claim 67 recites “identifying *grid cells on a projection plane* which are under or related to a projection associated with the bounding volume of said selected 3-D surface or sub-element” (emphasis added). This suggests that a bounding volume can be evaluated in terms of a number of grid cells. In any case, each of Salesin’s grid cells

“covers a fixed-size rectangular block of pixels (or possibly a single pixel) of the final image.” Ex. 1002, p. 2, col. 1. Thus, Salesin’s cells may be defined as finely as a single pixel.

As to the z-direction, the *zmin* and *zmax* values “need not represent the smallest such interval”; however, “the programmer might code a very precise scan-conversion procedure that computes the tightest z range possible for each tile,” depending on the programmer’s tolerance for inefficiency. *Id.* at p. 3, col. 2. We find that, in the case of a small xy bounding box, with cells at a pixel level of granularity, for example, and the tightest possible z range for each tile in the bounding box, a 3-D surface will be enclosed in the smallest imaginary right quadrangular prism whose edges are parallel to the axes of the group coordinate system.

As to Salesin’s disclosure that computing the tightest z range possible for each tile “may also be inefficient since it means wasting a lot of computation on objects that may become obscured later on,” Ex. 1002, p. 3, col. 2, Patent Owner argued at the oral hearing that Salesin teaches away from a bounding volume. Tr. 31:23–32:15. Petitioner’s contention, however, is that Salesin anticipates claim 67, not that it renders claim 67 obvious. “Although [an] alleged teaching away would be relevant to an obviousness analysis, ‘whether a reference “teaches away” from [an] invention is inapplicable to an anticipation analysis.’” *ClearValue, Inc. v. Pearl River Polymers, Inc.*, 668 F.3d 1340, 1344 (Fed. Cir. 2012) (quoting *Celeritas Techs., Ltd. v. Rockwell Int’l Corp.*, 150 F.3d 1354, 1361 (Fed. Cir. 1998)). Thus, we are not persuaded by Patent Owner’s argument.

Patent Owner further argues that Salesin does not describe evaluating a bounding volume as to visibility. PO Resp. 2. Rather, Patent Owner

contends, Salesin discloses evaluating the contents in a ZZ-buffer one cell at a time. *Id.* However, as explained above, during its scan conversion phase, Salesin “take[s] each object [and] compute[s] a rough [*zmin*, *zmax*] interval for every cell that may contain some part of the object.” Ex. 1002, p. 3, col. 1. Moreover, Salesin discloses that, “[i]n the scan conversion phase, we estimate the set of cells that each object covers, either totally or partially.” *Id.* at p. 3, col. 2. Thus, Salesin does not limit evaluating the contents of a ZZ-buffer to one cell at a time.

Also, as Petitioner points out (Pet. 32–33), Salesin discloses “scan convert[ing] an enlarged three-dimensional bounding box of [an] object.” *Id.* at p. 8, col. 1. This is another example of evaluating a bounding volume as to visibility. At the oral hearing, Patent Owner argued that this description in Salesin was “completely unrelated” because, here, Salesin is “not taking about objects” and instead is “talking about shadows.” Tr. 35:3–16. We are not persuaded. Although Salesin’s discussion is in the context of producing penumbrae (soft shadow edges) when rendering objects, it nevertheless describes rendering objects, including computing the visibility of a part of a “three-dimensional bounding box of [an] object” onto grid cells. Ex. 1002, p. 8, cols. 1–2; Ex. 1013 ¶ 114. Thus, Petitioner has shown that Salesin discloses evaluating a bounding volume as to visibility.

Patent Owner does not present any evidence or argument contesting Petitioner’s showing that Salesin discloses the remaining limitations of claim 67. In any case, Salesin describes a two-phase process for generating 3-D images: scan conversion, during which a ZZ-buffer is created, and rendering, where visibility is determined. Ex. 1002, p. 3, cols. 1–2, p. 5, col. 1. Thus, Salesin discloses a “method in 3-D computer graphics for processing the

visibility of 3-D surfaces before a subsequent step of visibility computations,” as recited in claim 67.

We also find that the cells of the two-dimensional array shown in Salesin’s Figure 1 are grid cells that are related to representations of objects stored in the cells’ tilelists upon an imaginary plane formed by the two-dimensional array. Ex. 1002, p. 2, cols. 1–2. Moreover, as construed in Section II.A, a “z-buffer” is “a data structure in memory that is used to store depth data.” Salesin’s ZZ-buffer is a data structure that represents cells based on a z-buffer. Ex. 1002, p. 2, col. 2. Specifically, Salesin discloses “perform[ing] a quick visibility test, based on the *zmin*, *zmax*, and *opaque* attributes of the new tile and of the ZZ-buffer entry.” Ex. 1002, p. 2, col. 2. Thus, Salesin discloses “for each of said grid cells, accessing the corresponding z-buffer element,” as recited in claim 67.

In sum, we conclude that Petitioner has proved by a preponderance of the evidence that claim 67 is anticipated by Salesin.

2. Obviousness of Claim 11 over Salesin and Foley

Petitioner contends that Salesin teaches each limitation of claim 11 except “said 3-D surfaces are arranged in a hierarchy represented by patches in varying levels of details.” Pet. 27–29. Petitioner argues that Foley teaches the missing limitation and that it would have been obvious to combine the teachings of Salesin and Foley. *Id.* at 29–31. The parties dispute whether a skilled artisan would have combined Salesin and Foley.

a. Salesin's Teachings

Salesin describes a two-phase process for generating 3-D images: scan conversion, during which a ZZ-buffer is created, and rendering, where visibility is determined. Ex. 1002, p. 3, cols. 1–2, p. 5, col. 1. The rendering phase relies on the depth and opacity information determined in the scan conversion phase. *Id.* at p. 5, col. 1. Thus, Salesin discloses a “method of reducing a step of visibility computations in 3-D computer graphics from a perspective of a viewpoint,” as recited in claim 11.

Salesin teaches “computing, before said step and from said perspective, the visibility of at least one entity selected from 3-D surfaces and sub-elements of said 3-D surfaces, wherein said computing step comprises at least a comparison between a pair of depth-related numbers to determine which of the surfaces or the sub-elements of the surfaces associated with said numbers is closer to said viewpoint,” as recited in claim 11. In particular, Salesin teaches discarding tiles if their minimum depths (*zmin* fields), from the perspective of a viewpoint, are greater than the maximum depths (*zmax* fields) of other tiles in the cell. Ex. 1002, p. 2, col. 2–p. 3, col. 1. As detailed above, Salesin discloses that the visibility of at least one tile is computed during this scan conversion step, which occurs prior to a rendering step. Ex. 1002, p. 2, col. 2–p. 3, col. 1.

Salesin also teaches “skipping, at said step, at least an occlusion relationship calculation for at least one entity that has been determined to be invisible in said computing step,” as recited in claim 11. For example, Salesin describes throwing away tiles that are obscured completely by other tiles. Ex. 1002, p. 2, col. 2–p. 3, col. 1. No visibility computations, including occlusion relationship calculations, are performed in Salesin’s

rendering phase on tiles discarded during the scan conversion phase. *Id.* at p. 3, cols. 1–2.

Patent Owner does not introduce evidence or argument disputing Petitioner’s showing that Salesin teaches these aspects of claim 11.

In a “Further Work” section, Salesin states that “[i]t seems it would be easy to extend the ZZ-buffer algorithm to directly handle objects that are defined recursively, such as fractal terrains or Bézier patches.” Ex. 1002, p. 14, col. 1 (internal citations omitted).

b. Foley’s Teachings

According to Dr. Teller, Foley is a standard textbook in the field of computer graphics that would have been familiar to a person of ordinary skill in the art. Ex. 1013 ¶ 111.

In separate sections of the textbook, Foley describes “level-of-detail elision” in which “successively more detail appear[s] as the user dynamically zoom[s] in on” an object, Ex. 1003, at 3, and Bézier patches, *id.* at 5–6. According to Dr. Teller, Foley describes Bézier patches as “smooth three-dimensional surfaces that are defined through repeated subdivision and blending of a set of vertices of the patch being represented.” Ex. 1013 ¶ 111 (citing Ex. 1003, at 5–6).

c. A Skilled Artisan Would Have Combined Salesin and Foley to Arrive at Claim 11

Petitioner contends that the combination of Salesin and Foley teaches “said 3-D surfaces are arranged in a hierarchy represented by patches in varying levels of details,” as recited in claim 11. Specifically, Petitioner

argues that Salesin explicitly states that its technique could be extended to handle recursively defined surfaces such as Bézier patches, and that Foley describes the characteristics of Bézier patches as well as other recursively defined surfaces such as level-of-detail elision. Pet. 29–30. According to Petitioner, Foley describes Bézier patches as surfaces that are arranged in a hierarchy of patches in varying levels of detail. *Id.* at 29–30. Relying on Dr. Teller, Petitioner argues that the overlapping discussions of Bézier patches in Salesin and Foley, Foley’s status as a standard reference in the art, and the similarity of the problems addressed by Salesin and Foley would have led a skilled artisan to combine Salesin and Foley. Pet. 30 (citing Ex. 1013 ¶ 111).

Patent Owner argues that Petitioner’s combination is based on Petitioner’s contention that elision, as described in Foley, is similar to Bézier patches. PO Resp. 3. According to Patent Owner, Petitioner has not explained adequately what it means by “similar.” *Id.* Dr. Teller, however, explained that Bézier patches “are smooth three-dimensional surfaces that are defined through repeated subdivision and blending of a set of vertices of the patch being represented” and, thus, “are well-matched to applications requiring varying levels of detail, since it is straightforward for an application to specify that a patch should be drawn coarsely (using a relatively small number of large polygons) or finely (using a relatively large number of smaller polygons).” Ex. 1013 ¶ 111. Thus, elision and Bézier patches, according to Dr. Teller, are alternative ways of representing patches in varying levels of detail. Nevertheless, because we conclude that a skilled artisan would have combined Foley’s teachings regarding Bézier patches

with Salesin's teachings, we need not determine that a skilled artisan also would have looked to Foley's teachings regarding elision.

Patent Owner also argues that Salesin does not state or suggest what it will do with Bézier patches and that Petitioner's arguments are speculation. PO Resp. 3. In reply, Petitioner argues that "recursive" in the context of Salesin means "iterative" at progressively finer levels of resolution and, that by stating that its technique could be applied to recursively-defined surfaces, Salesin teaches applying the ZZ-buffer algorithm to the same regions of the surface at several different resolutions. Reply 4–5. At the oral hearing, Petitioner clarified that, in its proposed combination, Salesin's algorithm would not have been modified. Tr. 46:21–47:12. Rather, the same algorithm would have been applied at different levels of detail. *Id.* We agree with this reading of Salesin's suggestion to extend its technique to Bézier patches.

Patent Owner further argues that, by teaching throwing away a new tile if it would be obscured completely by existing tiles and throwing away existing tiles if they would be obscured completely by a new tile, Salesin teaches away from a hierarchy of patches. PO Resp. 3. Similarly, Patent Owner argues that applying a recursive process to Salesin would contradict the process Salesin actually discloses. *Id.* at 4. Petitioner replies that by stating that its technique could be applied to Bézier patches, which Foley describes as representing patches in varying levels of detail, Salesin expressly teaches applying its technique to 3-D surfaces that are arranged in a hierarchy represented by patches in varying levels of details. Reply 4–5. We agree with Petitioner. Patent Owner does not introduce persuasive evidence or argument that Salesin would have discouraged or led a skilled

artisan in a direction divergent from application of the ZZ-buffer algorithm to a hierarchy of patches. *See In re Gurley*, 27 F.3d 551, 553 (Fed. Cir. 1994).

Patent Owner also argues that Salesin, at p. 3, col. 2, states that some variations on its technique might be economically impractical, illogical, or undesirable. PO Resp. 4. Here, Salesin explains that the *zmin* and *zmax* fields of a tile could be encoded with the tightest possible range, but that such approach could be inefficient. Ex. 1002, p. 3, col. 2. Patent Owner, however, does not explain how this applies to Salesin's statement that its technique could be applied to recursively defined surfaces. Thus, we are not persuaded by this argument.

Finally, Patent Owner argues that Salesin's discussion of application of its algorithm to recursively defined surfaces appeared in the "Further Work" section of the paper and was simply a proposal for additional funding. PO Resp. 3. The apparent lack of any subsequent article discussing such further work, Patent Owner argues, evidences that there was no interest in such an application. *Id.* at 4. Even assuming that Salesin was seeking to generate interest for additional funding and that no additional funding came, Patent Owner does not explain why this contradicts the clear suggestion in Salesin to apply the ZZ-buffer algorithm to recursively defined surfaces. *See Orthopedic Equip. Co. v. United States*, 702 F.2d 1005, 1013 (Fed. Cir. 1983) ("[T]he fact that the [prior art] would not be combined by businessmen for economic reasons is not the same as saying that it could not be done because skilled persons in the art felt that there was some technological incompatibility that prevented their combination. Only the latter fact is telling on the issue of nonobviousness.").

In sum, Petitioner's evidence shows that Salesin expressly suggests applying its technique to Bézier patches. Ex. 1002, p. 14, col. 1. As explained by Dr. Teller (Ex. 1013 ¶ 111) Foley teaches that Bézier patches are patches in varying levels of detail. Ex. 1003, at 4–5. Thus, combining the teachings of Salesin and Foley would have resulted in the application of Salesin's technique to "3-D surfaces [that] are arranged in a hierarchy represented by patches in varying levels of details." We are persuaded that a skilled artisan would have sought a standard textbook, such as Foley, to better understand Bézier patches and, thus, a skilled artisan would have had reason to combine Salesin and Foley. As detailed above, Salesin teaches the remaining limitations of claim 11.

We have weighed Petitioner's evidence and argument against the arguments presented by Patent Owner. Upon consideration of all the evidence, we conclude that Petitioner has proved by a preponderance of the evidence that claim 11 would have been obvious over Salesin and Foley.

III. CONCLUSION

Petitioner has demonstrated by a preponderance of the evidence that claims 1, 8, 11–13, 46, 57, 64, 65, and 67 of the '047 patent are unpatentable based on the following grounds:

- (1) claims 1, 8, 12, 13, 46, 57, 64, 65, and 67 as anticipated under 35 U.S.C. § 102(b) by Salesin; and
- (2) claim 11 as obvious under 35 U.S.C. § 103(a) over Salesin and Foley.

IV. ORDER

For the reasons given, it is

ORDERED that, based on a preponderance of the evidence, claims 1, 8, 11–13, 46, 57, 64, 65, and 67 of U.S. Patent No. 6,618,047 B1 are held unpatentable; and

FURTHER ORDERED that, because this is a final written decision, parties to this proceeding seeking judicial review of our Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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