

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

MERCEDES-BENZ USA, LLC,
Petitioner,

V.

YECHEZKAL EVAN SPERO,
Patent Owner.

U.S. Patent No. 9,955,551
Case IPR 2023-01039
Case IPR 2023-01040

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DEPOSITION OF DR. NIKOLAOS PAPANIKOLOPOULOS

FRIDAY, FEBRUARY 23, 2024

9:55 P.M.

Washington, DC

REPORTED BY:

SHERRY L. BROOKS, CERTIFIED LIVENOTE REPORTER

JOB NO. 28642

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I N D E X

DR. NIKOLAOS PAPANIKOLOPOULOS	PAGE
Examination by Mr. Turner	5

E X H I B I T S

EXHIBIT NO.	DESCRIPTION	PAGE
Exhibit A	Detection and Classification of Vehicles	19

(Exhibit attached to transcript.)

Washington, DC, Friday, February 23, 2024

9:55 a.m. - 3:44 p.m.

P R O C E E D I N G S

* * * * *

WHEREUPON,

DR. NIKOLAOS PAPANIKOLOPOULOS

having been previously first duly sworn, was examined
and testified as follows:

EXAMINATION

BY MR. TURNER:

Q. Great. Good morning, Doctor.

A. Good morning.

Q. And could you pronounce your last name for
me, please?

A. Sure, Nikolaos Papanikolopoulos.

Q. Papanikolopoulos?

A. Yes.

Q. Okay. I apologize in advance if I
mispronounce it.

A. No problem.

Q. I probably will.

Do you know why you're here today?

A. Yes.

Q. Why are you here?

A. To opine about my declaration about the

1 patent '551.

2 Q. Okay. And do you understand you're here
3 for a deposition today for two IPRs, IPR 2023-01039
4 and IPR 2023-01040?

5 A. Yes.

6 Q. Okay. Great. Have you been deposed
7 before?

8 A. Yes.

9 Q. Approximately, how many times?

10 A. Five times, including an ITC case.

11 Q. An ITC case. Okay. Have you been deposed
12 for an IPR before?

13 A. Yes.

14 Q. And do you remember the parties in that
15 IPR?

16 A. It was Canon against an entity. It was
17 about a video tripwire. It was Toyota against -- I
18 think Advances Solutions or something like that.

19 Q. So you were offering your opinion for --
20 on behalf of Toyota?

21 A. Toyota and Canon.

22 Q. And was that -- were they the petitioner
23 or the petition owner in the case?

24 A. They were the petitioner.

25 Q. Okay. And how did you prepare for your

1 deposition today?

2 A. So I try -- since, it's more than six
3 months since I prepared my declaration, I look at
4 some of the references. I look at the declaration.
5 I had several phone calls with counsel and I came
6 here.

7 Q. Okay. And so which counsel did you meet
8 with to review your declaration?

9 A. With Scott.

10 Q. Okay. Anyone else?

11 A. Joe was in and out. Basically, Scott.

12 Q. Okay. Did you meet with anyone outside of
13 the law firm, Hogan Lovells?

14 A. No.

15 Q. Okay. And which documents did you review
16 in preparation for your deposition?

17 A. My declaration, two volumes, each one for
18 the -- my bio and basically the '551 patent and some
19 references involved like Alden, A-L-D-E-N.

20 Q. Did you review any documents that are not
21 referenced in your declaration?

22 A. No.

23 Q. I'm going to give you a declaration here.
24 Do you recognize this document?

25 A. Yes.

1 Q. Okay.

2 A. This is the first IPR. Am I right?

3 Q. Correct. I don't think there's a label on
4 it, but that's -- let's see.

5 On the top page can you read which patent
6 is challenged or which patent this is in reference
7 to?

8 A. Patent 9,955,551.

9 Q. Okay. And does it list an IPR number on
10 the front page?

11 A. No. It says case to be assigned.

12 Q. Okay.

13 A. There is a side note here.

14 Q. Yeah. That's -- actually, that's my
15 Post-it note. So this one -- I'll just explain to
16 you this is IPR 2023-01039. I guess your counsel
17 will let us know if that's the wrong number.

18 A. Yep.

19 Q. Okay. Can you turn to the last page of
20 the document?

21 A. My signature page?

22 Q. Your signature page. So I guess that's
23 the second to the last page. All right.

24 Do you recognize your signature? Is that
25 your signature?

1 A. Yes, indeed.

2 Q. Okay. Excellent. So this is Exhibit 1003
3 from the IPR proceeding. So we won't need this as an
4 exhibit. It's already of record.

5 Do you remember how much time you spent
6 preparing this Exhibit 1003?

7 A. It's tough to tell because I work also on
8 three other IPRs at the same time involving the '503
9 patent. So I will say this particular one was around
10 40 hours total, give and take.

11 Q. Okay. And who did you work with while --
12 in preparing your declaration?

13 A. With Scott and Sally, the associate who
14 work here, S-A-L-L-Y.

15 Q. So she also -- she's an attorney with the
16 same firm, Hogan Lovells?

17 A. Yep.

18 Q. Okay. So who drafted your declaration?

19 A. I have full control. Some parts I
20 drafted. Some parts were drafted under my direction.
21 But every statement that's contained here had my
22 final approval.

23 Q. And what did you rely on in preparing your
24 declaration?

25 A. I rely on references listed on the back on

1 Appendix C and some POSITA, understanding of the
2 technology at the time in 2002 involving cameras,
3 headlights, lighting, optics, computer vision.

4 Q. So you said you relied on the documents
5 listed in your exhibit list and also you said your
6 understanding of a POSITA?

7 A. Yes.

8 Q. And what is your understanding of the
9 POSITA, what is that based on?

10 A. Let me go to my -- let me make sure that I
11 have -- if you go to page 15: "A person of ordinary
12 skill in the art in the field of the '551 would have
13 had an undergraduate degree in mechanical
14 engineering, electrical engineering, automotive
15 engineering, optical engineering, applied physics,
16 computer science, or similar disciplines, along with
17 two years of experience working with intelligent
18 vehicle systems, automotive control systems, or
19 lighting control systems.

20 "The more education one has, the less
21 experience needed to attain an ordinary level of
22 skill. Similarly, more experience in the field may
23 serve as a substitute for formal education."

24 Q. So this is your definition of a person of
25 ordinary skill in the art from paragraph 33 of your

1 declaration. That's what you were just reading?

2 A. That's right.

3 Q. Okay. So what is an intelligent vehicle
4 system as used in your skill level?

5 A. At the time general -- because I have been
6 working on intelligent vehicle systems since 1994 and
7 there are some examples of my -- let me go back.

8 So if you go -- so if you go to just
9 before paragraph 14, this is work done in the mid
10 '90s. And I have been working on using cameras in
11 order to control the traffic light and extend the
12 traffic signals so the pedestrian can have enough
13 time to cross the street.

14 Now, another example is basically just
15 before paragraph 21, page 9 where in I believe 1997,
16 winter, we use a camera in order to follow a license
17 plate and keep a safe distance from the car ahead of
18 us.

19 So to me an intelligent vehicle has gone
20 through several iterations, but this shows that we
21 have been working on this broader area of controlling
22 lights, of basically having this information to
23 autonomously and semiautonomously control the car.

24 So to go back to your question, an
25 intelligent vehicle is a system that can assess its

1 environment, the driving intentions of the driver,
2 and can make decisions such as following a path,
3 avoiding obstacles, following the lanes, or
4 interacting with other vehicles or pedestrians.

5 In 2002 at the same time as part of the
6 system that was supported by many agencies, including
7 the Minnesota Department of Transportation, we
8 coauthored a paper with Osama Masoud, M-A-S-O-U-D,
9 and Gupte, G-U-P-T-E, on tracking of vehicles and
10 pedestrians where basically the system was able to
11 detect headlights and using the headlight information
12 in order to make inferences about the movement of
13 cars at night.

14 So I don't know -- I tried to summarize.

15 Q. Okay. So let's -- all right. So let's go
16 back a minute.

17 So you were just describing this paper you
18 authored. Is that referenced in your declaration?

19 A. Yes. This is the paper. My paper,
20 Detection and Classification of Vehicles published in
21 the --

22 Q. I'm sorry. Sir, are you reading?

23 A. Yes. I'm reading the title. It's
24 paragraph 16.

25 Q. Okay.

1 A. This is the paper. It's basically still
2 the most cited paper. And this particular
3 transaction is where I happen to be the senior editor
4 for basically anything that has to do with imaging
5 and sensing for intelligent transportation systems.

6 And I explain in paragraph 16 how we use
7 headlights and taillights in order basically to
8 direct traffic or basically assist police at traffic
9 control, if there is an incident, and so on and so
10 forth, or if you have a situation that may be
11 dangerous like, for example, a crash or a pedestrian
12 or vehicle incident.

13 Q. All right. So in your paper that's
14 titled, Detection and Classification of Vehicles,
15 what type of sensor did you use to detect these
16 vehicles?

17 A. Cameras.

18 Q. Cameras?

19 A. Um-hum.

20 Q. Were they mounted on a vehicle?

21 A. In this particular paper they were mounted
22 on the side of the highway.

23 Q. So not on the vehicle. So they were in a
24 fixed location?

25 A. In a fixed location.

1 Q. Okay. And what type of cameras were used?

2 A. These were the prior versions -- these
3 were Axis systems. I don't know if you're familiar,
4 A-X-I-S.

5 Q. Please explain. What's an Axis system?

6 A. It's just a camera that basically has a
7 heating element. So basically it can withstand the
8 weather conditions and lengths (phonetic) and imaging
9 sensor and then basically the electronics in order to
10 get images and transfer the images to our lab in
11 order to do the processing on the laptops, the
12 computational resources we had at that time.

13 Q. So these type of cameras, you said they
14 would transfer the images to a lab to do the
15 computations. So this wasn't like a real time
16 determination?

17 MR. HUGHES: Objection. Mischaracterizes
18 his testimony.

19 A. This was -- if my recollection is correct,
20 this was transferred to something that's called a
21 traffic control center in the Twin Cities controlled
22 by the Minnesota Department of Transportation.

23 So this was real time, and then in the
24 analysis of these systems there were components that
25 were done real time there and components that we did

1 offline basically to make sure that the algorithms
2 work or basically try to figure out the ground
3 truthing; in other words what can be detected, what
4 cannot be detected, and so on and so forth.

5 But there was a component of this work
6 that involved a real time system outside the Xcel
7 Center (sic). The Xcel Center is a large sporting
8 center -- event center in St. Paul where we have --
9 we have the task after an event happening at night to
10 monitor pedestrians and vehicles.

11 This was a real time because we were
12 trying actually to control actual traffic light to
13 direct the traffic, and this continues until now. We
14 have a system of hundreds of cameras. Of course,
15 they are far more advanced in the state of Kansas.

16 We try to assess in real time the truck
17 parking availability. Big trucks, they try to park
18 in the rest areas. So we try to communicate to the
19 drivers the openings. So you can see since '94 until
20 now we are still doing this line of work.

21 BY MR. TURNER:

22 Q. Okay. And this paper you're referencing,
23 when was this published?

24 A. 2002.

25 Q. Okay.

1 A. But you understand that in order to be
2 published in 2002, the work was done.

3 Q. Okay. Now the sensors you used, were
4 these stereo sensors?

5 MR. HUGHES: Objection. Form.

6 A. For this particular paper, no. For the
7 system at Kansas, these are what we call multicamera
8 systems. In other words, there are multiple cameras
9 that do the 3-D construction. So think of what we
10 call N cameras that basically have overlapping areas
11 in order to do this reconstruction basically that is
12 needed, end recognition.

13 BY MR. TURNER:

14 Q. All right. So you said that for this
15 paper you were not using stereo sensors. So, again,
16 what type of sensors were you using?

17 A. Stereo -- it's a stereo system. I will
18 say we need to separate sensors because we may have
19 different sensors. But stereo is basically when you
20 have two or more cameras, among other
21 implementations.

22 So these were plain cameras, exterior
23 cameras, that were detecting vehicle characteristics.
24 And, in fact, if my memory is correct, there is a
25 figure 2 where we show how we built the background

1 model for the extraction of vehicles at dusk, so when
2 the lighting is not really good.

3 Q. Okay. Now, did you include a copy of this
4 paper with your declaration?

5 A. No. I don't believe so.

6 Q. Okay. Do you recognize this paper?

7 A. Yes.

8 Q. Is this the paper you were just referring
9 to?

10 A. Yep.

11 Q. All right. Can you take a look at the
12 bottom right portion of page 37, the paragraph
13 starting with, "Despite."

14 A. "Despite the large amount"? This is where
15 you want me?

16 Q. Yes.

17 A. Do you want me to read it loudly?

18 Q. Well, actually, if you could read about
19 the bottom quarter of this, the sentence that starts
20 with -- yeah. Please read the paragraph.

21 A. "Despite the large amount of literature on
22 vehicle detection and tracking, there has been
23 relatively little work done in the field of vehicle
24 classification. This is because vehicle
25 classification is an inherently hard problem.

1 Moreover, detection and tracking are simply
2 preliminary steps in the task of vehicle
3 classification."

4 Q. So what do you mean by "detection and
5 tracking are simply preliminary steps in the task of
6 vehicle classification"?

7 A. There is a logic flowchart that requires
8 basically to extract features that can be used for
9 the -- so basically you need to detect the features
10 such as sign (phonetic) parts, headlights,
11 taillights. And they basically construct the models
12 that are going to help you do the classification.

13 And one of the things that we had to do as
14 part of this project was basically classify bigger
15 vehicles with respect to smaller vehicles. And in
16 particular, if you look at the federal standards of
17 big trucks, we are asked if we can use this
18 information in order to classify if this is something
19 -- six-wheeler or eight-wheeler basically, if my
20 memory is correct.

21 And there is another thing we had at that
22 time. Do you have a copy of my resume?

23 Q. Your CV?

24 A. Yeah.

25 Q. I think that was an exhibit to this.

1 A. It was an exhibit, if you can give me it.

2 MR. TURNER: So this is going to be --
3 this is Exhibit 1004 from the IPR. This was
4 previously marked.

5 The paper was not previously marked so we
6 will mark that now.

7 (Exhibit A was marked for identification
8 and was attached to the deposition.)

9 A. If you go to the selected recent grants,
10 this is page -- after my publications, my publication
11 list, do you see Selected Recent Grants?

12 BY MR. TURNER:

13 Q. Let's see. I see book chapters,
14 conference papers.

15 A. And then Selected Recent Grants. If you
16 see -- do you see in the middle it says: "A
17 Real-time Truck Parking Availability System for the
18 state of Wisconsin; A Real-time Truck Parking
19 Availability System for the state of Kansas"?

20 So if you go up, and then towards the
21 bottom we have sensing --

22 Q. Can you hold on just a second? You said
23 on this list there's real-time. Oh, I see.

24 A. Do you see 2016, 2019?

25 Q. Okay. "Real-time Truck Parking

1 Availability System" --

2 A. -- "System for the state of Wisconsin."

3 Q. Okay.

4 A. "A Real-time Truck Parking Availability
5 System for the state of Kansas." And above that we
6 have "Maintenance for the Truck Parking Availability
7 System over the state of Kansas."

8 So if we go back to 2000, we are doing a
9 lot of similar projects for the Minnesota Department
10 of Transportation and the Department of Homeland
11 Security and the working group against
12 counterterrorism.

13 And basically the idea was the following
14 -- and I mentioned this in my declaration -- over at
15 the 30th Street Station were classified vehicles
16 based, for example, on their movement and the
17 possibility of a threat to the infrastructure site.

18 So think of a big truck parking under the
19 Light Rail station or the rail station in
20 Philadelphia. So depending on the project there were
21 different needs for classification. Like, for
22 example, classification of a vehicle that may have a
23 threat, classification of a vehicle that may not
24 belong to the parking area.

25 Classification of a vehicle that basically

1 stays too long. So the classification -- my point is
2 that based on the needs of the particular funding
3 agency the classification was tailored to their
4 constraints, to the work scope that we had.

5 Q. So it wasn't classifying a car versus a
6 truck. This was more of a threat level of the
7 vehicle?

8 A. The first step it was car versus truck.
9 Second level was actually human versus -- because
10 there was also perimeter enforcement. So we don't
11 want -- and the same is true here. For example, at
12 the same time we had the project from MDOT, Minnesota
13 Department of Transportation, monitoring work zones;
14 in other words, monitoring workers plus trucks plus
15 traffic next to the work zone.

16 So the task was actually classified
17 workers, traffic, and big trucks as they were parking
18 or they were moving in the work zone.

19 I don't know if I answered your question.
20 And if I mention something else which I think is
21 relevant, if you go to my resume there is a paper --
22 in fact, I had to look at this equipment this week.

23 Do you see paper -- if you go to journal
24 publications number 74 -- if you go journal papers,
25 look at 73 and 74.

1 Q. Since these aren't page numbered, can you
2 put a star -- with the ones you're referencing, can
3 you just put a little note on the side so then that
4 will help later with the transcript?

5 A. Yep. So should I put one star or --

6 Q. One star or a circle just so it's a
7 reference for us later.

8 A. So this is a project -- this is -- these
9 are papers that -- basically, we tried to use a
10 camera provided by Honeywell, Inc. in order to count
11 the number of vehicle occupants inside the vehicle as
12 the vehicle moves in an HOV lane.

13 And then you see this is work that was
14 done in 2000. So why is this important? Because
15 this in order to detect the vehicle occupants and
16 count them, you know, because on an HOV lane you
17 cannot have more -- you need to pay extra.

18 So we developed the system in order to
19 enforce the usage of the HOV lane. Now, this
20 involved sensors --

21 Q. I'm sorry. Which number are you on?

22 A. 73 and 74.

23 Q. Okay. And you said these are from 2000?

24 A. These were published 2000 -- June 2000 and
25 April 2000.

1 Q. Okay. I think I'm looking at the wrong
2 ones. Can you read just the title of these papers?

3 A. Yes. "A Vehicle Occupant Counting System
4 Based on Near-Infrared Phenomenology and Fuzzy Neural
5 Classification." And the other one was "Automatic
6 Detection of Vehicle Occupants-The Imaging Problem
7 and its Solution."

8 So why am I mentioning this? At the same
9 time we're trying to use the techniques I mentioned
10 earlier in order to not only detect the vehicle,
11 classify as a vehicle violating the HOV, because
12 official vehicles were classified as non-violating,
13 and then do the task of penetrating the windshield
14 and then count occupants.

15 So at times you say that we have all these
16 different projects fitting: Detection, tracking,
17 classification. Some of these characteristics been
18 different based on the particular needs of the
19 project and the work scope.

20 Q. Okay.

21 A. And I can go -- I don't want to take your
22 time, but there are several other papers. For
23 example, driver fatigue detection. So think of a
24 camera inside the car that monitors the driver, if
25 the driver is fit to drive, and so on and so forth.

1 This is 19 where lighting was very
2 important because there were shadows, there were all
3 sorts of stuff.

4 Q. Okay. Why don't we go back to your paper?

5 A. Sure.

6 Q. So this is -- I think we marked that as
7 Exhibit A. So you were reading the paragraph on the
8 bottom right. And I think you stopped right after
9 your mention of the detection -- "Moreover, detection
10 and tracking are simply preliminary steps in the task
11 of vehicle classification."

12 A. Yep.

13 Q. So do you agree that classification is a
14 difficult problem?

15 A. In general? At that time? Give me a
16 little bit of context.

17 Q. In the time you wrote this paper, at that
18 time frame.

19 A. Yeah, agree.

20 Q. Okay. All right. Can you continue
21 reading that paragraph, please?

22 A. Moreover -- "Given the wide variety of
23 shapes and sizes of vehicles within a single category
24 alone, it is difficult to categorize vehicles using
25 simple parameters."

1 You want me to continue?

2 Q. Yes.

3 A. "This task is made even more difficult
4 when multiple categories are desired. In real-world
5 traffic scenes, occlusions, shadows, camera noise,
6 changes in lighting and weather conditions are a fact
7 of life.

8 "In addition, stereo cameras are rarely
9 used for traffic monitoring. This makes the recovery
10 of vehicle parameters such as length, width, height,
11 even more difficult given a single camera view."

12 You want me to continue?

13 Q. Yes.

14 A. "The inherent complexity of stereo
15 algorithms and the need to solve the correspondence
16 problem makes them unfeasible for real-time
17 applications."

18 And it should be noted here that what I'm
19 saying is actually in the context of what you see in
20 figure 1, 2, 3, which is basically a highway scene
21 that may have vehicles going very slowly or being
22 static, stationary, or basically completely parked or
23 when you have shadows.

24 What I'm trying to explain, you know,
25 there is recovery of structure; in other words, of

1 depth, by using multiple views of the same scene
2 instead of having two cameras that require
3 maintenance and things like that.

4 So it should be taken into context of this
5 particular set of applications that I mentioned and
6 that are depicted in these particular figures.

7 Q. All right. And these figures -- so these
8 are images from the camera?

9 A. Yeah. You can see the --

10 Q. So like on page -- there's a number of
11 images on page 39. Are these the ones you're
12 referring to?

13 A. 39 is just the logic used basically.

14 Q. Okay.

15 A. And the logic is highlighted by what --
16 the type of images we're dealing with. But if you
17 want to see, figure 2 have some -- basically the
18 initial background, which is the result of basically
19 processing images as they come in in real time and
20 then applies some of the math and the logic described
21 here.

22 Q. So initial background is the -- you're
23 referring to the image taken by the camera before
24 it's processed?

25 A. No. Think of an empty highway, so -- with

1 no one. This is the starting point. Then this is my
2 background model. Cars are coming in and going out.
3 I have changes in shadows occlusions. This model is
4 updated. This is the mask, we call it.

5 Q. Okay.

6 A. And then as new images are coming in, we
7 have this obstruction of the camera (phonetic) images
8 in real time from the model. And this gives us some
9 initial features such as headlights or taillights, if
10 we're talking at dusk, or, for example, rust or other
11 subtle salient features that will help us say, okay,
12 this may belong to a vehicle.

13 And then we use something -- if I recall
14 correctly, it's called bipartite graph, a graph with
15 two parts basically, in order basically to match
16 these features to the thing that we call vehicles or
17 pedestrians or whatever.

18 Q. Okay. So you're saying in the system --
19 you described in your paper this is a -- the camera
20 is fixed. So you're taking a picture of the
21 background scene without any vehicles to compare it
22 to the vehicles when they're in the scene?

23 A. But if you do this you're going to have
24 failure very quickly. Why? Because basically, this
25 background model changes. Think of a road in the

1 morning and a road after it snows -- it's very common
2 in areas -- or some rain or some shadows. So you
3 need to continuously in real time update this
4 background model.

5 And this is -- I think the reason why this
6 paper was cited so many times -- there are two
7 reasons. One is actually that we provided a way that
8 people can do this in real time and also a way that
9 we can do the classification as well by using very
10 noisy information.

11 Q. I'm sorry. Very noisy?

12 A. Information. In other words, look at the
13 quality of the images we are talking here. I mean,
14 it's not -- it's not the greatest.

15 Q. And you're referring to the images on page
16 39?

17 A. 39, even the background adaptation that
18 happens. Look, for example, figure 4, the top row, A
19 and B.

20 Q. Figure 4, that's on page 42, correct?

21 A. Yep.

22 Q. Okay.

23 A. The top ones. And then going back to the
24 classification -- if you can go at figure 9 you can
25 see snapshots of different car, truck classification

1 results. Cars are shown surrounded by their bounding
2 box. Non-cars are marked by drawing the diagonals of
3 the bounding box.

4 And you can see some of the operation of
5 the system in real time. So you can see the
6 classification was basically -- it gives you more
7 information about what we were trying to do for MDOT,
8 Minnesota Department of Transportation, in this
9 particular case.

10 Q. So in these images is the bounding box
11 different or is the bounding box a function of what's
12 in the image?

13 MR. HUGHES: Objection. Compound.

14 A. The bounding box is just a graphical -- in
15 this case, it's a graphical illustration in order to
16 convince our funding agency that basically we can
17 separate these objects. That's why this is not a
18 classical (sic) bounding box because some of them --
19 they have the diagonals inside.

20 Again, we are talking about work that was
21 done late '90s, 2000 in order for the paper to be
22 published in 2002.

23 BY MR. TURNER:

24 Q. All right. Can you turn back to page 38?

25 A. Yep.

1 Q. All right. Can you read III on the left
2 side of the page under Overview?

3 A. I can read it, but I think I would need to
4 mention all six stages --

5 Q. Okay. Please.

6 A. -- or at least mention stage Number 1 is
7 the segmentation.

8 Q. Again, so these six stages, these are the
9 six stages of what that you're describing here?

10 A. These are basically the logic, the
11 algorithmical part, I would say, used.

12 Q. Okay.

13 A. Second is region tracking. Third is
14 recovery of vehicle parameters.

15 Q. Could you read point 3, please?

16 A. "To enable accurate classification of the
17 vehicles, the vehicle parameters such as length,
18 width, and height need to be recovered from the 2-D
19 projections of the vehicles. This stage uses
20 information about the camera's location and makes use
21 of the fact that in a traffic scene, all motion is
22 along the ground plane."

23 The other steps are step -- states vehicle
24 identification, vehicle tracking, and vehicle
25 classification.

1 Q. All right. So if we could go back to
2 point 3, with your system you used the fixed sensor,
3 correct?

4 A. Yes.

5 Q. Okay. So could this be done using moving
6 sensors like sensors mounted on a vehicle?

7 A. Yes, but it depends on the context. Like,
8 for example, in my declaration I have this
9 information of vehicle following paragraph 20.

10 Now, again, the constraints that we have
11 from MDOT, the Minnesota Department of
12 Transportation, we want less hardware because less
13 hardware means less maintenance, less impact from
14 weather conditions. For example, these cameras need
15 to be heated, the removal of snow, and so on and so
16 forth.

17 And also the stuff that you see here is
18 from the most -- there used to be the point where I
19 believe -- if my memory serves me well because this
20 is 20 years plus -- is where 94 and 35 W merge
21 (phonetic), which is one of the deadliest and most
22 prone accident areas.

23 So we couldn't fiddle. We were not
24 allowed to go with the truck with a cherry picker and
25 install cameras and stuff like that. So all told,

1 this is what we have. Tell us what you can do.

2 So what you see here is basically -- it's
3 a paper, but I didn't think much at the beginning but
4 became very much cited because basically it was not
5 something out of a lab. It was not a lab experiment
6 where we run a simulation. It was with a constraint.

7 We were trying to give information to MDOT
8 basically to do this stuff. If we had the free
9 environment like we had in Kansas, for example, the
10 technology we had then, it would have been probably a
11 different implementation.

12 Q. Okay. And the Kansas project, that's
13 something -- what time frame was that that you were
14 working on that one?

15 A. The Kansas project started -- let me make
16 sure. Do you want me to put a star on this as well?

17 Q. Sure.

18 A. So Kansas, 2016, and I'm going to have the
19 first one. But this was the outcome of a federal
20 highway project. It was based on the outcome of the
21 federal highway project that started in 2012, I
22 believe.

23 Q. Okay. Now, your project 2012 to 2016 was
24 the Kansas project?

25 A. No, 2016 until now and we just got renewed

1 for another five years. We maintained as the
2 University of Minnesota all the cameras and the
3 related systems and truck rest areas in Kansas, 22
4 sites.

5 Q. Okay. And now are those fixed sensors or
6 those are moving sensors?

7 A. It's a mixture of the things.

8 Q. All right. So the project you were
9 describing in your paper from 2002, you were using
10 fixed sensors?

11 A. Yeah. In this particular -- and, in fact,
12 it were (sic) not even our sensors. It were (sic)
13 available infrastructure from MDOT. As I mentioned,
14 we couldn't go. And if my memory serves me well,
15 these were either image sensing systems sensors, the
16 Autoscope or Axis. But I may be wrong because --

17 Q. And can you turn back to page 37 of your
18 paper, please?

19 A. Yes.

20 Q. On that paragraph you were reading from
21 before on the bottom right, the last sentence you
22 refer to a correspondence problem.

23 Do you see that?

24 A. Yes.

25 Q. What do you mean by a "correspondence

1 problem"?

2 A. So correspondence is, I detect a feature.
3 How do I know that this corresponds? It's not an
4 artifact. And how do I know that this corresponds
5 either to an object of interest or an object that I'm
6 following or I'm interested in?

7 Q. Okay. So how did you address this -- the
8 correspondence?

9 A. Well, this structure that I mentioned,
10 bipartite graph and the algorithm, which is -- again
11 --

12 Q. These were the steps that -- the stages?

13 A. Yeah -- I mean, if you look -- give me a
14 minute because basically it has been quite some time.

15 Q. Okay. Maybe it would help if you read the
16 whole sentence when we were talking about the
17 correspondence problem.

18 A. "The inherent complexity of stereo
19 algorithms and the need to solve the correspondence
20 problem makes them unfeasible for real-time
21 applications."

22 Q. So you're referring to a correspondence
23 problem with stereo algorithms or stereo sensors?

24 A. Yes. Basically, when you try to find --
25 if this feature in one camera belongs to the other,

1 in this particular scenario that I mentioned here,
2 highway real-time applications, it was -- we didn't
3 have the computation or the resources to do it.

4 That's basically --

5 Q. In real time?

6 A. In real time at the intersection of the
7 connection between 35W and 94.

8 Q. So that's a location where highways merge?

9 A. Yes. Basically, you have two highways.
10 So it's not only -- so they ask us -- the project is
11 about extracting real time information.

12 So, for example, I cannot have stereo.
13 Second of all, I cannot have a box of resources to
14 solve this.

15 Q. And you said you can't have stereo.
16 That's by the constraints or that's just the
17 technology at the time that you couldn't have stereo?

18 A. By the constraints of the site. I mean,
19 if you see -- it's so tight it has been already
20 designed. But it's so tight that basically we
21 wouldn't even be -- they wouldn't even let us access
22 this place. You see what I mean?

23 Q. The site of the highway?

24 A. Yes, because basically the cameras were
25 mounted, first of all, on the side of the highway,

1 all on buildings, private buildings, where we didn't
2 have access. So when we were asking can we go and
3 install more sensors -- I don't know if I answered
4 your question.

5 Q. Okay. So in this sentence you're saying
6 that the stereo algorithms, the stereo sensor type
7 approach makes them unfeasible for real-time
8 implications?

9 MR. HUGHES: Objection. Mischaracterizes
10 his testimony.

11 A. What I said is, basically, if you look at
12 this particular paper, it describes classification of
13 vehicles in freeway traffic in a large metropolitan
14 area where basically we are given the sensors and we
15 are asked what we can extract.

16 So what I'm saying is that as we design
17 the logic, our choice for this real time freeway
18 application with all these constraints was actually
19 to work to use the existing cameras and try to see
20 what we can accomplish.

21 As I mentioned, for example, the Kansas
22 Department of Transportation problem, the parking
23 assessment, there are multiple -- as I mentioned,
24 multiple overlapping cameras with stereo or
25 tri-stereo, or the project I mentioned to you,

1 vehicle occupant detection.

2 We were able to use our own cameras mostly
3 around places and were able to triangulate; in other
4 words, to solve this correspondence problem.

5 BY MR. TURNER:

6 Q. So in this sentence you refer to the
7 inherent complexity of these stereo algorithms that
8 made them unfeasible -- they were unfeasible at that
9 time. But you're saying they became feasible when
10 you were working on the Kansas project?

11 A. No. I said -- I say in this particular
12 freeway application at that time -- let me try to --
13 so if you look at intelligent vehicles at that time
14 there were a lot of efforts on basically using video
15 streams acquired at some time and then I process
16 them.

17 But I have the ability to work this in the
18 lab, add additional sensors, and do whatever I want.
19 Here we try to use an existing set of cameras at an
20 actual site and see if we can do for Minnesota
21 Department of Transportation classification.

22 So in this free-flowing highway system we
23 solve -- to have stereo, first of all, it was not --
24 it was a constraint we were not allowed to overcome.

25 The second problem actually we couldn't

1 have a box next to it. So -- and the correspondence
2 problem requires this box, this logic, to be there
3 running to solve it. So we said, okay, with this
4 existing can we do classification effectively?

5 And the classification where it is doing
6 is the one that I highlight with this -- with the
7 rudimentary graphics, basic graphics in figure 9.
8 And I believe these were from another site where we
9 try similar constraints to do our method.

10 Something that I want to be accurate. If
11 you see -- go to page 42. The graph we use is called
12 the association graph, so I stand corrected. There
13 may be a bipartite graph in the background, but
14 basically this is the meat -- one of the key steps in
15 this logic we follow.

16 Q. So the association graph, is that what's
17 shown in the middle of this page with the dots with
18 arrows extending between them?

19 A. Yeah. So, basically, we tried to
20 associate -- so do you see original tracking?

21 Q. Which page is it?

22 A. It's page 40.

23 Q. Okay.

24 A. So original tracking basically says --
25 think of it -- think of two headlights, okay, at

1 night and maybe it will have partial view.

2 So these are regions which are extracted.
3 So how do we make association of these to an entity
4 that we call a vehicle? This is basically what it
5 does because you may have -- in a scenario like this
6 you may have a lot of interesting combinations.

7 So this is -- we think -- and as -- this
8 is a decent way of solving this association problem.
9 Think of how you move from basic features such as
10 light intensities, two objects. Think of a bright
11 spot here and another bright spot.

12 Q. You're referring to, again, the figures on
13 page 40?

14 A. Yeah. If you look above this is a general
15 depiction of how -- when you look at the feature
16 figure 2b, what are the first things someone may
17 observe? In other words, what are the first things
18 that the camera may observe?

19 They're going to be the pair of
20 headlights.

21 Q. Okay.

22 A. So how mathematically we can capture this
23 and we can say that these two headlights based on the
24 use of some constraints with respect to the models of
25 cars exist and correspond to an object.

1 Q. So figure B shows these vehicle at night.
2 So figure A --

3 A. At dusk. It's not exactly at night in
4 particular because it shows everything in the
5 caption, just to be accurate, background and
6 adaptation to changes in light and conditions. The
7 initial background provided the algorithm. This is
8 A.

9 B, image of the scene at dusk. Car and
10 background after four seconds. Car and background D,
11 after six seconds. Car and background after eight
12 seconds.

13 So you can see the system recognizes these
14 features, it extracts them, and then it sees my model
15 -- my background model changes slightly because it's
16 getting darker.

17 But I don't -- I don't incorporate these
18 headlights because they are temporary in my view to
19 information that I incorporate. What does this mean?
20 It means if I compare this map, this image, to the
21 car and the image map that is coming in, then
22 basically I will get the features I want.

23 Think of this as my model of the scene in
24 front of me, of what I see.

25 Q. So these images at C, D, and E, this is

1 the same. It's just an image taken a few seconds
2 later?

3 A. No. This is the model as it's updated
4 every two seconds.

5 Q. So this is the model, not the image that's
6 taken?

7 A. This is the model that is informed from
8 the images and is used in order to compare the
9 incoming image with the model in order to -- you say,
10 okay, I have a new -- in order to get to this stuff
11 -- you see there are all these steps that I mentioned
12 earlier --

13 Q. Right.

14 A. -- in figure 9. Again, I wish I had the
15 ability to show you this video because we have this
16 video in front of the Xcel Center (sic). It's pitch
17 black and we track pedestrians and vehicles based on
18 headlights and taillights.

19 Of course, not -- it's like 60, 70 percent
20 accurate. But we can get the density of how many
21 vehicles, if there is flow, if there is no flow, if
22 there is divergence of individuals.

23 Q. Okay. And this video you're referring to,
24 this is from the project described in the paper or
25 this is the current project like the Kansas project?

1 A. No. No. No. This is at that time. As I
2 mentioned, we had the huge set of projects serving --
3 think of \$60-, \$70,000 project to do certain tasks
4 for the Minnesota Department of Transportation.

5 I mean, if we go back Minnesota had one of
6 the first with California -- Minnesota had one of the
7 first intelligent transportation centers in the
8 country. So we are very likely to have funding to do
9 all these variations from highways to arterials to
10 work zones to HOV lanes to you name it.

11 Q. Can you turn to page -- let's go to page
12 43.

13 A. Yes.

14 Q. All right. Can you read the paragraph
15 under the section, Recovery of Vehicle Parameters?

16 A. Let me see. Can you point me, 46?

17 Q. Sorry, 43. Page 43 on the right side
18 there's -- under the heading Roman numeral VI,
19 Recovery Vehicle Parameters?

20 A. "To be able to detect and classify
21 vehicles, the location, length, width, and velocity
22 of the regions (which are vehicle fragments) needs to
23 be recovered from the image. Knowledge of camera
24 calibration parameters is necessary in estimating
25 these attributes.

1 "Accurate calibration can therefore
2 significantly impact the computation of vehicle
3 velocities and classification."

4 You want me to continue?

5 Q. Yes, please.

6 A. "Calibration parameters are usually
7 difficult to obtain from the scene as they are rarely
8 measured when the camera is installed. Moreover,
9 since the cameras are installed approximately 20 to
10 30 feet above the ground, it is usually difficult to
11 measure certain quantities such as pan and tilt that
12 can help in computing the calibration parameters."

13 You want me to continue?

14 Q. Yes, please.

15 A. "Therefore, it becomes difficult to
16 calibrate after the camera has been installed. One
17 way to compute the camera parameters is to use known
18 facts about the scene. For example, we know that the
19 road, for the most part, is restricted to a plane,"
20 which is indeed the case for this freeway.

21 "We also know that the lane markings are
22 parallel and lengths of markings, as well as
23 distances between those markings are precisely
24 specified. Once the camera parameters are computed,
25 any point on the image can be back-projected onto the

1 road.

2 "Therefore, we have a way of finding the
3 distance between any two points on the road by
4 knowing their image locations."

5 Q. Okay. So in this paragraph you're
6 describing a calibration process. And your sentence
7 here, "one way to compute the camera parameters is to
8 use known facts about the scene."

9 So this is in your test you had a fixed
10 sensor location. So would you be able to use this
11 process if you had a dynamic scene where you didn't
12 have known facts about the scene, like if this was
13 mounting the camera on a moving vehicle?

14 A. This is -- if you can help me a little bit
15 narrow down, because let me tell you something which
16 is very important from this paragraph.

17 Q. Okay.

18 A. For liability reasons they wouldn't let us
19 drive even at night. So what we suggested at that
20 time, we said we are going to rent a University of
21 Minnesota vehicle with a pattern and we are going to
22 drive the highway back and forth because we didn't
23 want someone to go on the highway in the middle of
24 the night with a pattern.

25 So they told us forget it. So we said,

1 okay. What can we do? And this is the tool that you
2 see here. Now, in a vehicle following we can use the
3 information. For example, vehicles have certain
4 dimensions. License plates generally appear to be in
5 the center.

6 So we use the symmetry axis and we use the
7 voting scheme in order to find. So the pixels from
8 the image vote about the symmetry axis of the
9 vehicle.

10 So there are a lot of different ways that
11 you can do this. This is driven by the fact that we
12 couldn't go -- so you give me a scene, let's say
13 Kansas, where we have had this problem, or something
14 -- there is wind that blows and the cameras get
15 misaligned.

16 We have a way of using, for example, any
17 metric like the height of a tree. Someone measures
18 the tree. We can use it and then we can calibrate
19 the space. But there we didn't have any access to
20 this space, nor I wanted to risk the graduate
21 students to be there in front of there.

22 Q. The pattern?

23 A. The pattern.

24 Q. So a pattern is one way to calibrate?

25 A. It's one of the many ways. But for this

1 particular application we told them, Can we drive at
2 night? I mean, I recall because I ended up driving
3 the truck at one point because I didn't want anyone
4 to have the liability. But this was not feasible.

5 Q. So this was the truck that was being
6 detected or you had sensors mounted on the truck
7 itself?

8 A. No. We had patterns on the truck. Think
9 of black dots. Sometimes they are used by NASA in
10 order to basically do the docking. So you have
11 rhombuses, so -- or triangles, black, white
12 triangles. And we're trying to calibrate. But this
13 is not feasible. You cannot have me on the rental
14 truck.

15 Q. Okay.

16 A. So some of the statements -- and I think
17 this is the interesting thing about this paper. It
18 was so heavily constrained but still we were able to
19 do something that it was interesting.

20 MR. TURNER: We've been going for a while.
21 Do you want to take a break?

22 THE WITNESS: It's up to you.

23 MR. TURNER: Five minutes?

24 MR. HUGHES: That's fine.

25 (A break was taken.)

1 BY MR. TURNER:

2 Q. I have another exhibit for you, Dr.
3 Papanikolopoulos.

4 A. Can I take this out?

5 Q. You can just set it aside for now. We may
6 come back to those.

7 All right. Are you familiar with the
8 document I just gave you?

9 A. Yep.

10 Q. What is this document?

11 A. It's a patent application by Alden and the
12 title is Segmented Distribution Headlight System,
13 Method, and Apparatus.

14 Q. And this exhibit is marked Exhibit 1005.
15 It's already in the record. Are you okay if we refer
16 to this as the Alden reference or just Alden?

17 A. Yes.

18 Q. So what does Alden describe?

19 MR. HUGHES: Objection. Form.

20 A. Can you tell me -- it describes many
21 things. So where do you want me to focus?

22 BY MR. TURNER:

23 Q. What would you say is the purpose of the
24 Alden reference?

25 A. Let me try to look at my --

1 Q. Sure.

2 A. Just let me be sure. It's a little bit
3 open-ended. It says many things. So I'm going to
4 paragraph 46. And I'm going to say that Alden -- I'm
5 just reading.

6 "Alden is directed to a headlight system
7 with individually-controllable LEDs such that
8 different areas in the field-of-view of the vehicle
9 can be illuminated in different ways. For example,
10 high beam and low beam areas can be created
11 concurrently."

12 And if I can go because I think it's
13 important. It says -- give me one minute because I
14 think --

15 Q. And you were just reading there -- you
16 were reading from your declaration?

17 A. Yes, from my declaration.

18 Q. Paragraph 46?

19 A. 46.

20 Q. Okay.

21 A. So let me -- one minute. So paragraph 2,
22 the last sentence: "The result" -- on page 1.

23 "The result is an automated headlight
24 system which enables the driver of a vehicle so
25 equipped to see optimally while concurrently the

1 driver of an oncoming (or alternately a leading)
2 vehicle also can see optimally."

3 And my comment here is actually by having
4 reduced glare.

5 Q. Okay. Can you read starting at the
6 beginning of that paragraph, please?

7 A. "The present invention provides a
8 significant advancement in variable distribution
9 headlights by providing a means to automatically dim
10 some portions of the headlight distribution pattern
11 while concurrently keeping other portions of the
12 headlight distribution pattern illuminated on high
13 beam."

14 Q. So what does Alden mean by "keeping other
15 portions of the headlight distribution pattern
16 illuminated on high beam"?

17 A. Well, we have to look at the particular
18 aspect because this is the background and the field
19 that he mentioned.

20 So he mentions different things, including
21 -- if you go to 61 the last sentence, it says: "It
22 will be understood that the present invention can
23 also be used to operate a segmented light
24 distribution system to provide illumination to
25 independently controlled segments each operable

1 within a range of intensities between the high beam
2 and the low beam state."

3 Q. All right. So you're just reading from
4 paragraph 61?

5 A. 61, the last sentence.

6 Q. Okay. So back -- if we go back to
7 paragraph 2 --

8 A. Yes.

9 Q. -- so do you agree that Alden describes a
10 system that keeps the beam pattern at high beam but
11 then selectively automatically dims some portions?

12 A. I think it's one of the objectives. But
13 if you look at figure 11, for example, we have
14 another usage. It's basically by using -- the
15 reflector is 157. If you look also at the -- I
16 believe this is 36 paragraph. It's using the system
17 in order to have a lot of light on the curve of the
18 road and less light in areas of no interest.

19 So I see multiple usages of this
20 technology. So one is the glare and -- minimize the
21 glare for the driver of a vehicle who might be
22 oncoming or a vehicle who is in front of us and
23 maximize the visibility for the driver where the
24 headlights on the vehicle -- where the headlights are
25 mounted on.

1 And also from figure 11 it has the dual
2 problem where we try to have maximum light on the
3 curve, maximum illumination.

4 Q. All right. Can you turn to Figure 1 of
5 Alden?

6 A. Sure.

7 Q. I'm sorry -- figure 2, please.

8 A. Yeah.

9 Q. So what is shown in figure 2 of Alden?

10 A. I think I will go to his description. It
11 is paragraph 11. "Figure 2 illustrates the elements
12 of a segmented distribution illumination process."

13 Q. Okay. What is element 61 in figure 2?

14 A. It's a segmented beam headlight.

15 Q. Okay. Now, is figure 2 -- is this a top
16 view or a side-view of the segmented beam headlight?

17 A. I think this is a top view. It can be a
18 side-view as well, but my first thought it was a top
19 view.

20 Q. And what are the lines extending from --
21 the lines that are marked as 65 and 63 that are
22 extending from element 61?

23 A. Let's go to the -- where that is
24 described. Give me one minute. 61 produces a high
25 beam in the first sector, 60. So "Some methods

1 employed within 61" -- so paragraph 26: "Some
2 methods employed within 61 to segment light into
3 independently controlled sectors are discussed later.

4 "61 produces a high beam in a first sector
5 65 while concurrently producing a low beam in a
6 second respective sector 63 (or dim beam) where the
7 41 is sensed."

8 Q. Okay. So now those other light beams that
9 are shown below 41, would those be high beams or low
10 beams?

11 A. I think with the annotation that all these
12 are high-level schematics and since I don't see any
13 object, I would say that I would look at this as high
14 beams. But, again, this is a high-level schematic.
15 It goes back to the top view, side-view.

16 Q. Right. So because there's no object, your
17 understanding is those would be high beams below?

18 A. Yeah. My understanding is more -- I look
19 at figure 2 in conjunction with figure 3, figure 4,
20 and figure 5 because this describes -- I mean, I
21 think figure 3 is very informative. Given what we
22 discussed earlier, it gives us how the algorithm
23 detects the vehicle 41.

24 And figure 4 gives us the logic and the
25 steps. And figure 5 gives us the LED, the selectable

1 LED operation.

2 Q. Okay. So if we could turn to figure 5.
3 So on figure 5 is this another -- is this a top view
4 or is this a side-view of this?

5 A. I think this is a top view but can be
6 viewed as a side-view. Again, it's a slice of a
7 vehicle light that consists of several slices.

8 Q. By slice, do you mean a section?

9 A. Yeah. Think of when you have a medical --
10 in medical imaging, you use an analogy. You have
11 slices. You put the slices together and you get the
12 3-D structure.

13 Q. Okay.

14 A. For example, you see the switch array 115.
15 And then you see the bright light control sequence,
16 which is basically the activation. It's calling this
17 array matrix.

18 Q. Now, on figure 5 is this a right headlamp
19 or is this a left headlamp?

20 A. I think it can be any one of these.

21 Q. So the switch array that's shown here is
22 used to control the light source in this headlamp; is
23 that correct?

24 A. The light sources, I would say, plural.
25 Again, it's a slice because -- I think Alden

1 discloses basically this array matrix either for the
2 left or the right.

3 Q. All right. And what type of light sources
4 are used in this array matrix shown in figure 5?

5 A. So it has -- in the figure 5 it has one
6 element 119. It says can be white LED -- this is
7 paragraph 29.

8 It says "The 119 can be white LED (or
9 alternate lighting mechanism)."

10 Q. All right. And what type of LEDs are
11 these? Are those described in Alden?

12 A. It says a white LED.

13 Q. Okay. And what is the shape of these
14 LEDs?

15 A. You mean of the physical structure or the
16 shape of the light used?

17 Q. The physical structure.

18 A. It's basically a light emitted diode.
19 They can come in many types. For example, basically,
20 you have -- I believe, if my memory serves me well,
21 now most of them are aluminum 60, 63, I believe. But
22 basically you have a blue emitting dye and then you
23 have phosphor on top, and basically you have the
24 white it says here.

25 Q. Now, are these LEDs -- they're mounted on

1 a substrate? Is that what's shown in figure 5?

2 A. They are mounted on this curve that
3 enables them to have this directionality that we
4 mentioned earlier, but each one of these is a
5 separate unit. You see it just basically is an
6 individual unit fully controllable either by
7 intensity or other methods, current.

8 Q. So each LED is individually controlled.
9 That's how Alden describes it?

10 A. Yes. And the way I see this -- I don't
11 know if you are familiar with something that's called
12 -- you can find it in a lot of European cars. It's
13 called LED matrix. I don't know if you have heard
14 the term.

15 Q. Please explain.

16 A. So Audi 2005 demonstrated what became
17 basically one of the standards. I don't recall
18 exactly the name. So, basically, think of LEDs
19 mounted on a curvy linear. In other words, the
20 surface has a curve.

21 And I recall they started 42 and now the
22 implementations by Porsche has thousands of them. So
23 each one of them can be fired depending on the task
24 that you want to accomplish.

25 Q. Okay. Is that described in Alden?

1 A. I think this -- this is described in
2 Alden. A combination of two, three, four, five is
3 basically this -- I mean, in totality this is the way
4 as a POSITA at that time they envisioned this. At
5 that time the LED markets were something very
6 interesting, but there was a lot of discussion.

7 For example, some of the automotive
8 engineering circles thought we keep high beam/low
9 beam. This had problems. You see glare, so on and
10 so forth. So there were discussions on basically
11 having this type of -- that's at least I think --
12 this is what is disclosed here.

13 I don't recall the name of the standard.
14 It's on top of my head.

15 Q. I'm sorry. What type of shape of LEDs is
16 disclosed in Alden?

17 A. By shape, you mean -- it's just a white
18 LED. At that time it was basically a compound diode.
19 The diode was implemented with the compound and then
20 you had the dye, either blue or ultraviolet, UV, dye.

21 And then you had a cover that will produce
22 the white, which was made out, I believe, of
23 phosphor. And some of them they have this plastic
24 polycarbonate cover in order to protect the LED.

25 Q. Okay. How many LEDs are disclosed in the

1 headlamp that's shown in figure 5?

2 A. Again, I want to tell you this is a
3 high-end schematic and we see a slice. So I can
4 count them, but it says the plurality of LEDs that
5 they need to cover the whole field of view.

6 Did I answer the question?

7 Q. Let's see. So my question was: How many
8 LEDs are disclosed in the figure 5 embodiment?

9 A. In plurality, because basically we have to
10 consider that this is a slice and this is a
11 high-level schematic.

12 Q. So by that, are you saying there's more
13 LEDs disclosed than what's shown in figure 5?

14 A. What I'm saying is actually this is a
15 schematic. So it just shows the concept, how this
16 thing works. I wouldn't count here because things,
17 for example, are out of scale. I mean, look at
18 Figure 1, for example. I think the important part is
19 actually you have a plurality of them and the fact
20 that you can class them based on the logic described
21 earlier in figure 4.

22 Q. So in figure 5 if this is what would be a
23 top view, are you saying we're looking at one row of
24 multiple rows or there's just a single row of LEDs?

25 A. What I'm saying is -- actually, this is

1 one slice. Let's suppose we're looking at the top.
2 So it's going to be a second slice, a third, and one,
3 two, three, four end from the bottom. This is
4 demonstrated from figure 4. If you look at 77 and 79
5 -- these are the control sequence --

6 MR. HUGHES: For the record, I think --
7 are you referring to figure 3, not figure 4?

8 THE WITNESS: Sorry -- figure 3 -- sorry.

9 MR. HUGHES: Yeah, just to be clear on the
10 record.

11 A. I stand corrected. Figure 3, 77, and 79.
12 If we go to the description, in paragraph 27 -- so if
13 you see 27, it says: "Information from the 72 and 71
14 is sent to control the power flow from a power source
15 via a left light control circuit 55a and a right
16 light control circuit 55b.

17 "Note that the left shaded circuit area 75
18 indicates the areas of a segmented headlight control
19 switch array switches which will cause portions of
20 the left headlight to be dim while a non-shaded left
21 circuit area 77 represents the portions of the
22 segmented headlight which will be on high beam.

23 "The 75 area is significantly larger than
24 the headlight dots that were initially received by
25 51a and 51b because, the CPU has made assumptions

1 about the space that may potentially be occupied by
2 the driver of the sensed vehicle."

3 And then he says: "Likewise, a right
4 shaded circuit area 81 indicates the areas of a
5 segmented headlight control switch array switches
6 which will cause portions of the right headlight to
7 be dim while a non-shaded right circuit area 79
8 represents the portions of the right segmented
9 headlight which will be on high beam."

10 So, in other words, to me, it's very clear
11 we're talking about a two-dimensional structure that
12 is map of this set of slices in figure 5.

13 BY MR. TURNER:

14 Q. So you're saying based on Alden's
15 description in figure 27 Alden's description of the
16 light control circuits based on that, that describes
17 how that informs your decision on what the shape of
18 the LED array is? Is that what you're saying?

19 A. No. What I'm saying is actually what --
20 the description of figure 3 gives you which elements
21 of this LED matrix or array are going to be
22 activated, which are going to be high beam, which are
23 going to be dimmed.

24 Q. Okay.

25 A. And, again, this is -- if you go to figure

1 4, it shows the logic. This is figure 4. If you
2 look at the element 89, so it says: "Is threshold
3 light present at A1L sensor position?" And then it
4 says: "Is threshold light present at A2L?" So still
5 at the left sensor, but basically introduces the
6 coordinates XY.

7 So, in other words, this is a
8 two-dimensional array image and try to find the dot.
9 And that does the same on the right sensor in
10 elements 93 and 95. And then it says: "I compile
11 left sensor map and I compile right sensor map,"
12 which are basically images, and then finally compare
13 the left map to the right map based on the memory.

14 And I do the tabulation and the other
15 steps that basically in the end informs the element
16 111, the drive -- sorry -- element 109 that requisite
17 headlight segments to dim. Switch other segments to
18 high beam.

19 Q. So in this section is there any expressed
20 disclosure of the shape of the LED array in figure 5
21 of Alden?

22 A. Let me read it. You mean that the LED
23 elements are placed on the curve or --

24 Q. Yes.

25 A. Give me a minute to read it. It says in

1 the middle of 29: "The 119 and other lighting
2 elements are on a curve along the focal point of a
3 headlight lens 121 such that the light from each
4 lighting element goes into a specified portion (or
5 portions) of the headlight distribution area."

6 Q. Okay. So this curve is along the focal
7 point of the headlight lens. So where is this focal
8 point shown in figure 5?

9 A. The focal point generally is associated
10 somewhere close to the center. Okay? Again, we have
11 to be -- the scale and things may be off, but this is
12 the optical control element that focuses the light
13 basically.

14 Q. Okay. Do you still have your pen?

15 A. Yeah.

16 Q. Do you mind? Can you identify the -- draw
17 the focal point on there?

18 MR. HUGHES: Objection. Calls for
19 speculation.

20 A. You see, as I mentioned, it will be
21 speculation because this is not to scale. So I don't
22 know anything about the focal length. I don't know
23 anything about, so I don't have the information to do
24 this.

25 BY MR. TURNER:

1 Q. Okay. Well, based on your understanding
2 of Alden, can you estimate the location of the focal
3 point?

4 A. It will be close to the lens. Generally
5 in this area, in this broader area of the center.
6 But I don't want to put down because basically these
7 things, as I mentioned in my disclosure, are
8 high-level schematics.

9 Q. Okay.

10 A. They try to articulate the concept
11 basically. Like, for example, 119 is associated with
12 this 15-degree segment and it tries to show what is
13 on.

14 Q. So the -- so you're saying -- which LED is
15 associated with the 15-degree segment?

16 A. You see there is a description about 119,
17 and he uses 119 as a representative of what is
18 happening -- uses 119 as the representative LED of
19 this controlled operation of the system by Alden.

20 It says: "For example, the power to 119
21 is controlled by the CPU" -- this is paragraph 29 --
22 "is controlled by the CPU which dictates its
23 respective switch characteristics at 115 such that
24 the power from a power supply 113 is carried via
25 segment wire 117 is controlled in response to the

1 sensed environmental conditions.

2 "All of the other light elements are
3 similarly individually controlled," which I think is
4 important. "The 119 and other" -- and then towards
5 the end of that, it says: "In the illustration, the
6 125 from 119 falls across the 15-degree section of
7 the headlight distribution area.

8 "Each other lighting element similarly
9 falls within a defined area of the light distribution
10 area. Thus, the light sent to the area of 41" -- I
11 believe 41 is referred to in figure 2 -- "is dimmed
12 using a headlight with segmented lighting means."

13 Q. Okay. So which LED illustrated in figure
14 5 generates the beam that's noted as the 15 degrees?

15 A. Do you see the one that says 119?

16 Q. So the one with the reference numeral
17 pointing to what would be the lowest --

18 A. The lowest one. And then you can see the
19 two rays that go through the lens and they create the
20 15-degree segment that you see under 125.

21 Q. Can you trace the rays that extend from
22 this light element to the 15-degree segment?

23 A. You can connect the center. Again, this
24 is high-level schematic. You can connect the two
25 centers that we see here or the two points that we

1 see here, and basically this is creating -- so we
2 connect the 119 with a point where we have all these
3 lines intersecting at the bottom.

4 And then we have the line that goes from
5 119 to the other upper intersection point. And this
6 creates this 15-degree segment.

7 Q. Okay. Can you mark it on the exhibit?
8 Can you trace these beam patterns extending from 119
9 to the --

10 A. I prefer to describe it because, again,
11 it's not -- it's not really in my -- I think I trace
12 them in my declaration with this preface. These are
13 pretty generic and high level.

14 Q. Okay.

15 A. So I think, for example -- let me find --
16 I think I have traced them in my -- so, for example,
17 this is the -- my declaration for the 2023-01039.

18 If you go to paragraph 69 at the end I
19 have these clusters. And you can see the 119 and
20 three LED. This creates one cluster.

21 So 119 and the two neighbors (phonetic)
22 create a noncontiguous cluster with the other three
23 LEDs on top of the curve that they're creating these
24 traces in order to illustrate, again, what is low
25 beam/high beam.

1 Q. All right. So you just described these as
2 being noncontiguous clusters. Which clusters are
3 these that are not contiguous?

4 A. If you go with me in --

5 Q. Paragraph 69?

6 A. -- 69 at the end, at the top of the page
7 47.

8 MR. HUGHES: Counsel, I think we may
9 actually be in the declaration for 01040.

10 MR. TURNER: I think I only gave him one
11 declaration so far.

12 THE WITNESS: I have IPR 2023-01039.

13 MR. HUGHES: Okay. Apologies, Counsel.

14 MR. TURNER: No problem.

15 BY MR. TURNER:

16 Q. All right. So you're referencing, was it
17 paragraph 69?

18 A. 69 at the end.

19 Q. So you were describing these as being
20 noncontiguous; is that correct?

21 A. Yes.

22 Q. And by noncontiguous -- which ones are
23 noncontiguous?

24 A. So do you see the three red at the bottom?

25 Q. Yes.

1 A. And look at the three pink ones at the --
2 so three pink at the bottom, three pink at the top of
3 the curve. Am I right?

4 Q. Okay.

5 A. So since there's a vehicle that it has
6 been sensed in the middle of the field of view as we
7 examine this slice, basically the first cluster of
8 LEDs which are the three, again, for graphical
9 presentation are green, because basically these are
10 dimmed by the control switch that I mentioned
11 earlier, 79 or 77, depending if it's left or right in
12 order to be dimmed.

13 Q. All right. And you're describing this
14 group of LEDs in the center that you've annotated in
15 green as they would be the ones that are generating
16 this portion of the beam pattern that you have
17 highlighted in green?

18 A. Yes.

19 Q. And now the upper grouping of LEDs that
20 you have as red or pink, do they generate the pink
21 portion of the light being on the bottom or the top
22 of this image?

23 A. So if you look at what I say -- so if you
24 look at -- the group on the top is representative for
25 the pink stuff on the bottom, the second -- the --

1 this part of the second (inaudible) there's no
2 object. There is no object present in this area, in
3 this area at the bottom.

4 And the ones on the top -- so, again,
5 think -- you see where 119 is and where are the 15
6 degrees per segment symbol is? These are produced --
7 the pink in this sector is produced by these LEDs
8 where 119 is a member of. And the other group of
9 LEDs is basically presenting the bottom part, the
10 other pink.

11 Q. Okay. So just to clarify, you're saying
12 the lower grouping of red LEDs which have reference
13 numeral 119 next to them, they're generating the
14 portion of the beam that you have highlighted in red
15 that you have marked as high beam at the top that
16 also has the 15 degrees per segment notation in the
17 figure; is that correct?

18 A. Yes. Yes.

19 Q. Okay. So then also -- so then the top
20 LEDs would be generating the pink beam on the lower
21 portion of the image?

22 A. Yes.

23 Q. Okay. And what type of optic is shown in
24 this figure -- is disclosed in figure 5?

25 A. Can you elaborate? Because optics is many

1 things.

2 Q. Okay. How would you describe the optic
3 illustrated in figure 5 of --

4 MR. HUGHES: Objection. Form.

5 A. The optics -- so the optical element 121
6 is optics. The LEDs are optics. The interaction of
7 the light with the 121 is optics. So which part do
8 you want me to do?

9 BY MR. TURNER:

10 Q. Element 121. How would you describe the
11 optic that's identified as reference Number 121?

12 A. It's -- according to Alden -- just to
13 follow his disclosure, he discloses -- let me read
14 this. The 119 -- this is paragraph 29.

15 "The 119 and other lighting elements are
16 on a curve along the focal point of a headlight lens
17 121 such that the light from each lighting element
18 goes into a specified portion (or portions) of the
19 headlight distribution center."

20 So he calls this a lens, discloses a lens,
21 and then talks about "Element emitted light 125 being
22 an example of an element's light being directed into
23 one sector of the light distribution area.

24 "In the illustration, the 125 from 119
25 falls across a 15-degree section of the headlight

1 distribution area. Each other lighting element
2 similarly falls within a defined area of the light
3 distribution area.

4 And then goes and says: "Thus, the light
5 sent to the area of 41 is dimmed using a headlight
6 with segmented lighting means."

7 Q. All right. So with reference to figure 5
8 Alden refers to element 121 as a headlight lens,
9 which you described as an optic.

10 What type of optic --

11 MR. HUGHES: Objection to the extent it
12 mischaracterizes testimony.

13 A. Can you repeat?

14 BY MR. TURNER:

15 Q. What type of optic is illustrated in
16 figure 5 of Alden?

17 MR. HUGHES: Objection. Form.

18 A. I mean, tied in what sense? I mean, in
19 the sense of Alden? In the sense of general optics?

20 BY MR. TURNER:

21 Q. I mean, based on your experience. For
22 example, would you describe element 121 as a concave
23 optic or a convex optic or another type of optic?

24 A. I'm describing this as something that
25 directs the light in a certain direction as a

1 function.

2 Q. Are there technical descriptions or terms
3 for this type of optic?

4 A. Lenses operate on a refraction. So here
5 you have no change wavelength when you go through
6 this optical medium, and you either focus or divert
7 depending on the type of optical element you have.

8 The other type of refraction is when you
9 go through a material and you change things. Like
10 you apply current and you change the properties of
11 the light. So if I can describe in great enough
12 terms, this is a lens which is based on pretty simple
13 refraction.

14 Q. Okay.

15 A. Which it focuses and directs in a certain
16 area. We shouldn't forget that the objective is a
17 control -- is a set of control abilities that tie to
18 maximize the visibility for the driver and reduce the
19 glare for drivers' vehicles which are coming towards
20 the vehicle where the headlight is mounted or
21 vehicles ahead of us.

22 Q. All right. Can you turn to figures 8 and
23 9 of Alden?

24 A. Yes.

25 Q. What is shown in figures 8 and 9?

1 A. Let's go to the document. So 17 it says:
2 "Figure 8, the element of an individual electro-optic
3 cell in a first state. Figure 9 is an electro-optic
4 material in a second state of alignment."

5 And figure -- paragraph 32 and paragraph
6 33 -- 33 gives more information about figure 8 and 34
7 gives more information about figure 9.

8 Q. All right. So these are described as two
9 different states. So on figure 8 what is this state?

10 A. Give me one minute. So it describes --
11 basically, the states are associated with a liquid
12 crystal. The first state is actually when there is
13 nothing applied, no current applied to the liquid
14 crystal. The second state is when something is
15 applied to the liquid crystal, if I read correctly.

16 Q. So figure 8 is like a default state where
17 no current is applied?

18 A. Yes.

19 Q. So what happens to the light that's
20 transmitted through that?

21 A. It just goes through.

22 Q. It just passes through?

23 A. Yes.

24 Q. And then what happens in the figure 9
25 state?

1 A. In the figure 9 state basically you have
2 some bending depending on the anisotropic properties
3 of the material and the current you apply, the
4 temperature and so on, and so forth.

5 Q. Okay. So by bending of the light that's
6 transmitted through the optic?

7 A. Yeah. Basically you have -- so liquid
8 crystal is quartz. It's a material -- it's an
9 element, an optical element, that is made out of
10 material that is anisotropic.

11 So by applying current and with respect to
12 the external pressure, property of materials,
13 humidity, so on and so forth, then instead of going
14 through you start getting this divergence basically,
15 this bending.

16 I don't know if I answered your question.

17 Q. All right. So now can you turn to figure
18 10? So what is shown in figure 10 of Alden?

19 A. Just give me one minute. So according to
20 paragraph 19: "Figure 10 depicts a segmented
21 headlight with individually controlled sectors of
22 distribution of the third embodiment."

23 So if we go to paragraph 35, it says:
24 "Figure 10 depicts a segmented headlight with
25 individually controlled sectors of distribution of

1 the third embodiment. A single light element 129a
2 produces collimated light due to collimating surface
3 131a.

4 "The light then passes through an array of
5 variable refraction elements (described in figure 9.)
6 This headlight architecture enables light from an
7 individual headlight distribution sector to be
8 redirected in response to sense environmental
9 conditions when used in conjunction with the elements
10 and processes previously discussed herein.

11 "Thus, light from one section has been
12 diverted to become diverted light 151 (in low beam
13 where a vehicle (not shown) has been sensed) while
14 the light from other segments are not diverted (are
15 in high beam) where no vehicle is sensed."

16 Q. Okay. So you were just reading. That was
17 paragraph 35 of Alden?

18 A. Yes.

19 Q. And this -- so figure 10, that's using the
20 --

21 A. The principle.

22 Q. -- the principle from figures 8 and 9,
23 those elements?

24 A. Yes.

25 Q. All right. Can you turn to figure 11,

1 please, of Alden?

2 A. Yes.

3 Q. So what is shown in figure 11?

4 A. That's where the records today I read to
5 you. Do you want me to --

6 Q. To describe what's shown, yes.

7 A. So we see a vehicle C approaching a curve.
8 The vehicle has two headlights. The vehicle is
9 denoted by the Number 153. The headlight is denoted
10 -- the right headlight is denoted by 155. There is a
11 reflector associated with the fact that we have a
12 curve on the road 157.

13 And then we have one of the sectors 159,
14 light sectors. I can go to more detailed
15 description. So it says: "An equipped vehicle 153
16 senses that the road turns by receiving light from
17 reflectors" -- this is paragraph 36 -- "such as the
18 reflector 157.

19 "The responding headlights 155 direct
20 light into the corner to maximize the driver's
21 ability to see there. The directing of the light can
22 be achieved with the segmented sensing elements and
23 segmented light distribution elements described
24 herein."

25 Q. Okay. So which of the light sources

1 described in Alden are used to generate this beam
2 pattern that's illustrated in figure 11?

3 A. Can you repeat the question just to make
4 sure?

5 Q. So we just discussed a couple different
6 headlamp embodiments, right? There's the figure 5
7 embodiment and then we just discussed one with
8 reference to figure 10 as a different type of
9 embodiment.

10 MR. HUGHES: Objection. Form.

11 BY MR. TURNER.

12 Q. So which of these embodiments or another
13 embodiment, the headlamp, is used to generate the
14 beam pattern illustrated in figure 11?

15 A. I need to go because I think I have an
16 explanation of what is used -- do you have a copy of
17 my -- of the other part of the declaration, the '551?

18 Q. I do.

19 A. If you can share with me, it would be
20 great.

21 MR. TURNER: So this is the other
22 declaration. It's the same exhibit number, but it's
23 from the other IPR. It's Exhibit 1003, and then I
24 think the IPR is listed on the little Post-it. So
25 that should be IPR 2023 and it's 01040.

1 A. Bear with me. I have a detailed
2 description. So in the IPR 2023-01039, if you go --

3 BY MR. TURNER:

4 Q. So that was the first declaration we're
5 talking about?

6 A. The first exhibit you gave me.

7 Q. Okay.

8 A. Go to paragraph 111, page 79. What I
9 described, basically the second usage of basically
10 the figure -- the figures 2, 3, 4, and 5, in order to
11 maximize to direct the light where there is a curve
12 and how can this be done with figure 5.

13 So do you see where in the center of the
14 page 79 it says claim 24g?

15 Q. Yes.

16 A. "By directing light into the corner, or
17 curve of the road, to maximize the driver's ability
18 to see there, the system is increasing illumination
19 in the direction of the curve.

20 "For example, Alden can recognize the
21 curve, determine which segments of the light
22 distribution area of the headlight lie along the
23 curve, and then switch the lighting segments that
24 direct light to those segments to be on high beam.

25 "This can be considered in reference to

1 figures 3 and 5 of Alden. The system of Alden would
2 detect the light from reflectors based on left and
3 right sensors.

4 "The logic CPU would then determine that
5 this light indicates the curve of a road, much in the
6 same way that it can detect an oncoming vehicle based
7 on its headlights, and the location and distance of
8 the headlights from the equipped vehicle."

9 This is figure 4, the controlling logic.
10 "Once this determination is made, the CPU would
11 instruct the control circuitry to adjust illumination
12 of the LEDs accordingly. In particular, LEDs pointed
13 in the direction of those reflectors can be switched
14 to high beam, while other LEDs directed towards other
15 areas can be switched to low beam.

16 "Further, a POSITA would have understood
17 from Alden that when positioning LEDs along the
18 curved structure in the headlamp (such as shown in
19 figure 5), LEDs could be positioned to ensure that
20 the beam created by the headlamp is sufficiently wide
21 to illuminate turns.

22 "That is, a POSITA would understand to
23 position the LEDs on each end of the array; for
24 example, far enough along the curve and at such an
25 angle that their emitted light would be directed

1 sufficiently to the sides of the vehicle.

2 "This directing of light into the corner,
3 as shown on figure 11 above, is an adaptation of the
4 light pattern of the headlamps."

5 So if we go to figure 4 of -- let me try
6 to add a -- so, again, we are in the first part of
7 the declaration, the same document I just read.

8 Q. Okay.

9 A. Go to paragraph 85. Do you see figure 3?

10 Q. Yes.

11 A. So here what does Alden disclose, that
12 when something -- if you look at 70 elements in
13 figure 3, 77 and 79, do you see the black boxes
14 inside?

15 Q. Yes.

16 A. So basically here what is happening, when
17 there is a detection like this, Alden, by using the
18 LEDs described in figure 5 and the corresponding
19 paragraph, makes this dim while the other has full
20 light in order to increase the visibility for the
21 driver.

22 In figure 11, I believe, the same
23 structural figure 5 can do the dual (phonetic). In
24 other words, I can have dots of the reflectors --
25 instead of having the dots that correspond to the

1 headlights, I have dots that correspond to the
2 reflectors on the side of the road.

3 So I want to -- as we drive, we want to be
4 able to see this better. So it's going to send as
5 much light as possible to this one by using the same
6 structure.

7 Q. Okay.

8 A. So it's the dual problem. Again, one is
9 actually high beam so I don't create glare for the
10 oncoming driver, or if I'm on a turn the system can
11 use these refractors (sic) by using the same logic of
12 detecting lights -- using the same reflectors in
13 order basically to just have direct LED light in
14 order for the driver to make inferences about the
15 curvature.

16 I don't know if this answers your
17 question.

18 Q. So using the figure 5 embodiment you're
19 saying that light reflects off these reflectors on
20 the side of the road and the headlamp detects these
21 and then dims those corresponding lights?

22 MR. HUGHES: Objection. Mischaracterizes
23 his testimony.

24 A. No. What I'm saying is the following:
25 There are two main use cases in Alden. One is

1 basically headlights maximizing visibility for the
2 driver and minimizing -- we discussed this.

3 The second one is actually using the same
4 logic, which is described in figures 3, 4, and 5. I
5 detect that, so my dots here in the figure 3 are
6 going to be the reflectors. The reflectors are going
7 to be something that corresponds -- it will have the
8 same appearance on the image like the headlights.

9 So I will have a rectangle like -- but
10 instead of having dim light I'm going to have high
11 beam, and the rest is of no interest because
12 basically I'm trying to compensate -- of course, I
13 have Alden discloses that he has information from
14 other sources such as the steering wheel sensor.

15 So I can have more information, the
16 driver, by having the light. So that's -- that's the
17 way -- to the best my understanding, this is what I
18 believe is disclosed here. And it's important to say
19 -- let me read just one minute.

20 The directing of lights -- I'm reading
21 from 36 at the end. "The directing of" the light --
22 "of light can be achieved with the segmented sensing
23 elements and segmented light distribution elements
24 described herein."

25 MR. TURNER: All right. It's 1:00. Do

1 you guys want to break for lunch?

2 MR. HUGHES: That's fine.

3 (Whereupon, at 1:01 p.m., a
4 luncheon recess was taken.)

5 - - -

6 A F T E R N O O N S E S S I O N

7 (1:43 p.m.)

8 Whereupon,

9 DR. NIKOLAOS PAPANIKOLOPOULOS

10 was called for continued examination, and having been
11 previously duly sworn was examined and testified
12 further as follows:

13 EXAMINATION (CONTINUED)

14 BY MR. TURNER:

15 Q. All right. Welcome back.

16 A. Thank you.

17 Q. All right. If you could turn to your
18 declaration. This is your first declaration, which
19 is for the 039 IPR?

20 A. Yes.

21 Q. Okay. Can you turn to paragraph 33?

22 A. Yes.

23 Q. Okay. We discussed this a little bit
24 before. This was your definition of person of
25 ordinary skill in the art. Can you read the last

1 sentence of your -- or the last two sentences?

2 A. "The more education one has, the less
3 experience needed to attain an ordinary level of
4 skill. Similarly, more experience in the field may
5 serve as a substitute for formal education."

6 Q. What is your understanding of these
7 sentences?

8 A. So the layman -- I'm not a lawyer -- so
9 let's suppose that you have a master's. Some of
10 these two years which I mention here may become one
11 year or zero. So if you have, let's say, four years
12 of experience, you may have a degree from a two-year
13 college like a community college. So basically
14 that's --

15 Q. That's the scale?

16 A. The scale, yes.

17 Q. Okay. All right.

18 A. For example, Dunwoody. It's a small
19 technical college in the Twin Cities. It has
20 automotive engineering. That's my point --
21 D-U-N-W-O-O-D-Y.

22 Q. All right. Can you turn to paragraph 50
23 of the same declaration?

24 A. Yes.

25 Q. All right. So this you're describing

1 ground 1?

2 A. Yep.

3 Q. Okay. Can you read paragraph 50 for us,
4 please?

5 A. "As viewed by a POSITA, Alden anticipates
6 and renders obvious Claim 48."

7 Q. So in your view what's the difference
8 between "anticipates" and "renders obvious"?

9 A. To me, anticipate -- what is happening
10 anticipate also renders obvious. It's above
11 everything.

12 Q. So it's --

13 A. Again, I'm not a lawyer, but --

14 Q. So in your view if something anticipates,
15 it also renders obvious?

16 A. Yes.

17 Q. If something renders something obvious,
18 does it also anticipate?

19 A. No.

20 Q. So anticipates --

21 A. Not necessarily.

22 Q. So for this ground 1 you have an
23 anticipates and an obvious analysis. So in your view
24 what is not expressly disclosed that would require
25 obviousness analysis?

1 A. In my view as we discussed this now, I
2 believe Alden anticipates. I mean, it has either
3 expressly or basically -- all the terms of the claims
4 are disclosed, taught by -- and we can go claim by
5 claim basically.

6 Q. So do you know which limitation you
7 provide your obviousness analysis for?

8 A. Let me -- in both declarations or --

9 Q. Just one at a time.

10 A. So we can talk about ground 2.

11 Q. Well, first with ground 1. Can we just
12 focus on ground 1 for now that you proposed
13 anticipatory reference and obviousness?

14 A. It's "or" render obvious. It's not "and."

15 Q. All right. So on this ground you're
16 analyzing claim 48; is that correct?

17 A. I don't think -- let me see.

18 MR. HUGHES: Counsel, which IPR petition
19 should we be looking at?

20 A. I don't see 48 on this one.

21 BY MR. TURNER:

22 Q. Okay. All right. Well, in paragraph 50
23 which independent claim are you analyzing in this
24 section?

25 A. You mean paragraph 50?

1 Q. How about at --

2 A. Let me understand. You want me to see --
3 because I'm at the Table of Contents.

4 Q. Well, if you can look at paragraph 50,
5 which is page 23.

6 A. Should I start with independent claim 24?

7 Q. Okay. So for -- I'm sorry. Did you say
8 dependent claim or independent claim?

9 A. Independent claim.

10 Q. So for independent claim 24 what are you
11 relying on for satisfying the light source
12 limitations of this claim?

13 MR. HUGHES: Objection. Vague.

14 A. So the way I analyzed this is actually I
15 started with the preamble and I say basically what
16 are the elements of the claim. So are you referring
17 to the preamble where it says an illuminating device
18 having automatic control? Because I go term by term.

19 BY MR. TURNER:

20 Q. Why don't we scroll down to limitation 24
21 B, which is at the bottom of page 26?

22 A. Yep.

23 Q. So what are you relying on for satisfying
24 the LED limitations of this claim?

25 A. It's a plurality of the individual control

1 abilities.

2 Q. Okay. What are you relying on for
3 satisfying the plurality of individually controllable
4 LED limitation?

5 A. So if you go to 54, I say: "As discussed,
6 Alden discloses that its 'segmented beam' headlights
7 61 are incorporated in 47. See supra paragraphs
8 52-53, claim 24a Also Alden figures 1 and 2.

9 "Each headlight can include an 'array of
10 individual lighting elements,' with each lighting
11 element being a 'white LED (or alternate lighting
12 mechanism),' which is from 29 paragraph in Alden.

13 "That is, the plurality of LEDs are
14 incorporated in the motor vehicle structure by being
15 included in headlights 61, which are mounted to the
16 vehicle."

17 And, in fact, dependent on 26 and 29 in
18 figure 2, if we go to figure 2, there is the element
19 47 which is the vehicle itself which shows that this
20 whole thing is mounted on the vehicle.

21 So "further, this LED array ('lighting
22 elements 119') is in communication with a power
23 source ('power supply 113') via a 'switch array 115'
24 and 'segment wire 117,'" which is basically figure 5.

25 You want me to continue?

1 Q. No. That's fine. Can you turn to
2 paragraph 120 of your declaration, page 87?

3 A. Yes.

4 Q. So for ground 2, are you combining Alden
5 with Kobayashi for claims 28, 36, and 44; is that
6 correct?

7 A. That's right.

8 Q. What are you relying on the Kobayashi
9 reference for teaching?

10 A. Do you have a copy of Kobayashi with you?

11 Q. I don't think I have Kobayashi. But did
12 you describe it in your declaration?

13 A. I describe it, but --

14 Q. Do you remember what you're relying on
15 Kobayashi for teaching?

16 A. Give me one minute to make sure that the
17 record is accurate. It's the GPS map. But let me --
18 so if you go to 121, page 89, specifically Kobayashi
19 discloses everything -- so it's under the figure on
20 page 89.

21 "Specifically, Kobayashi discloses that
22 its controller ('irradiation control means 4')
23 receives 'roadmap information' from 'road profile
24 calculated means 2,' along with other sensor data,
25 and use these inputs to automatically adjust the

1 illumination of headlamp 5.

2 "(Id.; see also 2:4-39.) The 'road
3 profile calculated means' can also be included as
4 part of a GPS sensor that outputs 'map information.'"

5 And I believe -- I don't have it in front
6 of me -- there is a figure 12 in 17, 3 to 47 where
7 basically the GPS -- so, in other words, think of the
8 following: Both Kobayashi and Alden are basically
9 trying to make the driving through the use of
10 headlights safer.

11 In addition to the information processed
12 by Alden, Kobayashi discloses the use of GPS in order
13 to have maps that are going to inform the driver
14 there is a curve.

15 So, for example, something like this may
16 be useful. Let's suppose we are in an environment
17 like New York where there's a curve, but this is what
18 we call a GPS denied environment. Then you relied on
19 these reflectors.

20 Now, you are in a rural environment where
21 you have a GPS but you don't have the reflectors. So
22 this map information along with the steering wheel
23 information can inform how these LEDs or the
24 combination will be turned on in order to focus the
25 light on the curve.

1 Q. And also another thing that -- I really
2 like this figure 10 from Kobayashi, which is on page
3 90 because it shows, "Kobayashi further discloses
4 that as a vehicle moves along roads in a travel
5 route, including, for example, traveling along
6 straight roads or bending roads, the 'irradiation
7 control means 4' can 'conduct irradiation control of
8 the lighting device in accordance with the road
9 profile.

10 "As a result, 'when the vehicle turns to
11 left, the left shoulder is irradiated,' and 'when the
12 vehicle turns to right, the right shoulder is
13 irradiated.'" And this is figure 2 (sic), 15:6-28,
14 17:41-67 and also figure 9."

15 Q. Okay.

16 A. I hope I answered your question.

17 Q. Yeah. That's fine. All right. Can you
18 turn to paragraph 124 of your declaration?

19 A. Yes.

20 Q. All right. So for ground 3 you're
21 combining Alden with Kondo for claim 8, 10 through
22 14?

23 A. Um-hum.

24 Q. What are you relying on the Kondo
25 reference for teaching?

1 A. If I may ask, do you have a copy or --

2 Q. I don't know if I have Kondo -- I do have
3 a copy of Kondo.

4 A. Thank you.

5 MR. TURNER: You guys want this?

6 MR. HUGHES: Thank you.

7 A. So you see paragraph 127 on page 96?

8 BY MR. TURNER:

9 Q. Yes.

10 A. So I'm reading the claim element: "The
11 light fixer having movable structure for aiming the
12 directional light sources mounted thereon in a
13 defined direction."

14 So if you look at Kondo, which is titled,
15 Automatic Optical-Axis Adjusting Device for
16 Automatically Adjusting the Directions of Optical
17 Axes of from Lights.

18 So it has -- "Kondo discloses vehicle
19 front lights comprised of swivel lights 11L-11R and
20 left and right headlights 10L-10R." This is
21 described on 16, I believe. Yeah. It's paragraph
22 16. It has the whole description.

23 And I use it also -- let me see -- for 8d.
24 I think that's -- yeah, these are there.

25 Q. Okay.

1 A. Basically, the swivel structure which
2 corresponds to their moving.

3 Q. All right. So you're relying on Kondo
4 swivel structure for satisfying the moving structural
5 limitations?

6 A. Yes.

7 Q. So how do you combine Alden and Kondo?
8 How would a person of ordinary skill in the art
9 combine these references?

10 A. I have a pretty good description. So go
11 to paragraph 131, page 99.

12 Q. Okay.

13 A. It says: "Further, a POSITA would have
14 had a reasonable expectation of success in using the
15 swivel structure (and associated actuator) taught by
16 Kondo to mount certain LEDs to in the system of
17 Alden.

18 "For example, LEDs in Alden (such as those
19 in figure 5) could be mounted to the movable
20 structure and controlled using the same controller
21 (Alden's CPU 71) that is already assessing how and in
22 what directions light should be projected - something
23 that Kondo similarly uses a CPU to assess."

24 Q. So are you saying that a person of
25 ordinary skill in the art would mount a -- use

1 Kondo's swivel structure to adjust the entire
2 headlamp assembly that's shown in figure 5 of Alden?

3 A. Um-hum. And I have actually -- so Lexus
4 has a swivel system along with LEDs introduced around
5 the time -- maybe one year later. So I think it
6 would have been something, because for someone to
7 introduce it means they were working on this for
8 several years at that time.

9 So also Audi -- I believe it had a swivel
10 system with LEDs at the same time. So I think the
11 POSITA would have been motivated because it increases
12 -- don't forget, we tried to increase the visibility
13 for the driver and decrease the glare.

14 Q. Okay. But your combination, you're
15 talking about moving the entire LED array of Alden,
16 not some subset of the LED array?

17 A. This is what I'm talking here as one
18 possibility.

19 Q. Okay.

20 A. But I know, for example, the Audi system
21 moves only certain LEDs in this matrix LED system
22 that we discussed.

23 Q. Okay. But that's Audi. But we're -- in
24 your combination are you moving the entire LED array
25 or a portion of the LED array?

1 A. What I mention is the whole, basically.

2 Q. Okay. All right. Can you turn to
3 paragraph 154 of the same declaration? It actually
4 starts at 153.

5 A. Yeah.

6 Q. Okay. So this ground 4 looks like you're
7 combining Alden with Kondo and Stam; is that correct?

8 A. Yes.

9 Q. What are you relying on the Stam reference
10 for teaching?

11 A. Again -- sorry to ask it -- do you have a
12 copy of Stam?

13 Q. I think I have Stam.

14 MR. TURNER: Again, so this would be
15 Mercedes Exhibit 1008.

16 A. Give me a minute. Yeah. So, basically,
17 if you go to paragraph 154 -- this is the one you
18 told me -- or 153?

19 BY MR. TURNER:

20 Q. I think the ground starts at 153, but it's
21 --

22 A. Yeah. I think for this particular, the
23 dependent claim, if you look at the figure on the
24 first page, which is System for Controlling Exterior
25 Vehicle Lights and we go to paragraph 154: "A POSITA

1 would have been motivated to implement the teachings
2 in Stam to the Alden-Kondo system.

3 "Stam is in the same field as Alden,
4 similarly discloses vehicles with headlamps that can
5 be controlled to change brightness and beam pattern
6 so as to 'maximize the illuminated area in front of
7 the vehicle without causing excess glare in the eyes
8 of other drivers.'

9 "Like Alden, Stam also receives data from
10 sensors, and controls the headlights to 'control
11 their beam patterns in response to objects detected'
12 in the vicinity of the vehicle."

13 Stam in here is -- so Stam discusses some
14 numerical values about glare. But here in this
15 particular case: "Stam merely adds that the same
16 image sensor and optical system 'for the headlamp
17 on/off and headlamp dimmer control' could also be
18 used to detect other conditions such as fog, and
19 other exterior lights on the vehicle like fog lights
20 could be controlled based on the sense information."

21 So, in other words, if we look at this
22 figure which is actually on page 117, there is the
23 element -- there are several sensors along with an
24 image sensor, which is element 201, is the image
25 sensor.

1 We have element 1107 of the light sensor,
2 we have glare lights sensor 1109, and EC mirror drive
3 1111, along with a microcontroller that through means
4 (phonetic) 1142 affects and instructs the fog lamp
5 control 1141 in order to change the fog lights 1147,
6 1145, and 1143.

7 So, again, since several vehicles have fog
8 lights which are used for additional visibility
9 around curves -- for example, BMW has this as a
10 standard feature. This, again, improves the
11 visibility around corners. Again, for a POSITA it
12 would have been reasonable to combine these two, to
13 combine Alden with Kondo with Stam.

14 Q. So, again, what limitation are you relying
15 on Stam for teaching?

16 A. Basically this closure about the fog --
17 the fog lamp controller. So, basically -- so Stam
18 merely adds -- this is paragraph 154.

19 So "Stam merely adds" -- this is paragraph
20 154. Stam merely adds that the same image sensor and
21 optical system 'for the headlamp on/off and headlamp
22 dimmer control' could also be used to detect other
23 conditions such as fog, and other exterior lights on
24 the vehicle like fog lights could be controlled based
25 on the sensed information."

1 So, in other words, he adds to the mix the
2 fog lights, which unfortunately in the U.S. are not
3 regulated.

4 Q. All right. So you're relying on his
5 disclosure of fog lights for teaching which claim
6 limitations?

7 A. So you see it says: "The illumination
8 device of claim 8, further comprising a controller
9 with communication capability to other devices, where
10 the camera in one location obtains information and
11 the controller processes the information and
12 communicates the camera obtained information to a
13 second device." The second device.

14 Q. So you're relying on Stam for satisfying
15 the second device or is it the structures of the
16 camera? Are you relying on Stam for satisfying the
17 camera limitation?

18 A. No. What I'm saying is actually both of
19 them -- the three of them, Alden combined with Kondo
20 and Stam make the whole thing obvious.

21 So we have illumination device of claim 8.
22 We have a controller. So both Alden and Kondo, they
23 have a controller. They communicate to other devices
24 where the camera angle allocation obtains
25 information. So I have an image sensor in Kondo. I

1 have an image sensor in Alden.

2 Where the camera in one location obtains
3 information and the controller processes the
4 information, microcontroller in Kondo, CPU logic in
5 figure 4 of Alden then communicates the camera update
6 information to a second device.

7 So in the case of fog, what does the
8 camera communicate? If we have basically no
9 visibility, the camera can capture and the processor
10 can make inferences regarding this and it can send
11 the obtained information to a second device.

12 In this case, this is the fog lamp control
13 who -- that impacts 1143, 1145, and 1147, which are
14 the fog lights.

15 Q. Okay.

16 A. And if you go to the patent claim 16
17 paragraph 165, basically -- and 155 says: "As
18 discussed, Stam discloses the microcontroller 1105
19 communicates the camera-obtained information to the
20 fog lights on the vehicle, and the illuminated area
21 of the fog lights is a road, and it would have been
22 obvious to apply these teachings to the Alden system
23 for the reasons explained above."

24 Q. So are you proposing adding fog lights to
25 Alden or you're using Alden's headlamp for fog light

1 functionality?

2 A. No. I don't do either of these. I'm
3 saying what is being -- what this reference teaches
4 is that basically we can take Alden with Kondo and we
5 can basically use Stam teachings, especially with the
6 operation of fog lights, and a POSITA would have
7 found these as applying known methods -- applying
8 basically these techniques in order to get
9 predictable results.

10 Because all of them dealing with lights,
11 automotive lights, and a fog light is just another
12 device that can be utilized and be informed to the
13 communication. So I'm not suggesting that this is
14 preferable. I'm just saying how a POSITA would have
15 looked at this prior art.

16 Q. So are you proposing adding additional
17 structure with this combination?

18 A. No. I'm just saying how these three
19 references -- you see, as I mentioned earlier, BMW I
20 think is one of the few manufacturers that have fog
21 lights that are activated on a curve on the road. It
22 doesn't mean that everyone adopts this.

23 And, in fact, as I mentioned earlier, the
24 U.S. has no directions, has no standards for fog
25 lights. In fact, the fog lights for a big

1 manufacturer, as far as I know, are the rear lights
2 on the back.

3 Q. All right. Why don't we turn to your
4 other declaration. Do you have your other
5 declaration from -- excuse me -- IPR 2023-01040? Did
6 I give you a copy of the other declaration?

7 A. Yes, yeah. This one. So this is --

8 Q. It's also marked Exhibit 1003, but this is
9 for the IPR 2023-01040. All right. Can you turn to
10 page 101, paragraph 143, please?

11 A. Paragraph 143, sure.

12 Q. All right. So for this ground you have
13 Alden alone or in combination with Stam in view of
14 Beam for claim 49; is that correct?

15 A. Yes.

16 Q. All right. So what do you mean by Alden
17 alone or in combination with Stam?

18 A. So let me read this. So let me explain to
19 you. Let's go to paragraph 146. This is 49b claim
20 element. So I say: "With respect to illuminance
21 being below a 'predefined glare level,' a POSITA
22 would have understood that for low beam to have
23 'minimum glare' as disclosed in Alden, the low beam's
24 intensity would need to be below a particular
25 threshold.

1 "Below" -- for example, "Below a level
2 such that the 'driver of 41 sees only a dim or low
3 beam light from 47.'" This is Alden 26 -- paragraph
4 26 to 27, figures 1 and 2.

5 "High beam light would be above this
6 threshold, so that, as Alden teaches, visibility in
7 high beam areas is maximized. (Alden 26 to 27.)
8 Further, Alden's system can 'provide illumination to
9 independently controlled segments each operable
10 within a range of intensities between the high and
11 the low beam state.'

12 "That is, Alden's system can operate not
13 only at high beam and low beam but also at
14 intensities in between medium low, medium, medium
15 high. The 'dimmed, low beam state' is a selected
16 intensity at the low end of this range and thus below
17 a predefined glare level that Alden characterizes as
18 'minimizing glare' to other drivers."

19 Again, Alden wants -- now, if we want to
20 see an example or a POSITA would have been interested
21 to see an example of predefined glare, numerically
22 meaning in units.

23 "Stam similarly" -- I'm going to paragraph
24 147. "Stam similarly discloses vehicles with
25 headlamps that can be controlled to change brightness

1 and beam patterns based on objects, so as to maximize
2 the illuminated area in front of the vehicle without
3 causing excess glare in the eyes of other drivers.

4 "Stam further discloses that predefined
5 threshold values can be considered in setting the
6 illuminance of low and high beams, and that
7 governments have laws limiting the intensity of
8 vehicle headlamps, including to control the amount of
9 glare experienced by drivers of other vehicles.

10 (1:16-2:5)

11 "Stam gives an example of limiting
12 headlight illuminance to below a threshold of '0.1
13 foot candles" -- so this is candles per square feet.
14 It's a unit that's used to measure illuminance --
15 "incident or other vehicles, to avoid causing glare
16 and to comply with regulations, and notes that when
17 no other vehicles are present, the lights can be on
18 high beam above this predefined threshold."

19 And then in 148 it says: "It would have
20 been obvious to use such a predefined glare level,
21 such as 0.1 foot candles, in the system of Alden.
22 This would have required nothing more than setting a
23 predetermined illuminance level to 'control the
24 amount of glare experienced by drivers' as taught by
25 Stam."

1 Q. Okay. So you're relying on Stam for
2 teaching a threshold level; is that correct?

3 A. Just giving this particular value.

4 Q. Okay.

5 A. If my argument -- my previous argument was
6 basically -- although I think it's rather obvious, I
7 use Stam to provide this particular figure.

8 Q. Okay. So now what do you rely on Beam for
9 teaching in this combination?

10 A. Give me one minute. Do you happen to have
11 Beam? I'm sorry to ask.

12 Q. I brought a lot of paper that I want to
13 get rid of.

14 THE WITNESS: And this is Exhibit No. 007
15 (sic).

16 MR. TURNER: So 1007?

17 A. Yes. Just give me one minute. Yeah. I
18 used from Beam -- should I describe Beam or no?

19 BY MR. TURNER:

20 Q. Well, just -- sure.

21 A. So Beam discloses like Alden a system --
22 this is paragraph 152. "Like Alden, Beam discloses a
23 system controlling headlight output patterns in
24 particular areas to eliminate 'the blinding of a
25 driver in an oncoming vehicle, while continuing to

1 provide intense forward illumination.'"

2 This is from Beam, Abstract and 1:5-19.

3 "Beam describes a vehicle headlamp system that uses a
4 'sensor 107' to detect light from other vehicles.
5 (Beam 4:9-59, 5:3-16, claims 1-6, figures 1-2, 4.)

6 "The sensor data is used by a controller
7 108 to adjust the output of a plurality of
8 individually controlled light sources, or
9 'microbeams,' making up the headlight beam in order
10 to attenuate beams directed to detect vehicles.

11 Q. Now, just that last sentence, when you say
12 "light sources or microbeams," are you --

13 A. I'm referring to this individual who uses
14 the term "microbeams."

15 Q. Okay. So what is a microbeam?

16 A. Let me go back and see. Bear with me one
17 minute, sir. So if you go to column 2, row 56 says:
18 "It will then control the light output of a group
19 selected from a multiplicity of narrow angle beams
20 (microbeams) which comprise the overall headlight
21 beam pattern."

22 So it uses these microbeams as components
23 of the overall headlight beam pattern.

24 Q. So the microbeam is a component of an
25 overall beam?

1 A. Headlight beam, according to the
2 disclosure here.

3 Q. All right. And what creates a microbeam?

4 A. So if you go to column 5, row 32: "Figure
5 7 is a block diagram of the electronics portion of a
6 controller 108. The spatial scene data from sensor
7 107 is thresholded to eliminate weak signals and
8 becomes the input to a processor.

9 "A clock generator produces a line clock
10 which determines the line to be read or illuminated,
11 and a dot clock, which determines the location of the
12 pixel on the line to be read or illuminated. The dot
13 clock output is connected to sensor, spatial light
14 modulator and a dot counter 1103 via a bus 1111.

15 "The line clock output is connected to
16 sensor 107, spatial light modulator 203 and a line
17 counter 1104 via a bus. The numeric value of dot
18 counter is transferred to processor 1105 via a bus
19 1113.

20 "The numeric value of line counter 1104 is
21 transferred to processor 1105 via a bus 1112.
22 Processor 1105 uses appropriate algorithms on the
23 incoming data to determine the locations to be
24 blanked, and stores them in memory 1106."

25 So, in other words, blank. So they don't

1 want any light there.

2 Q. So the microbeam is light?

3 A. Yeah. Produced, I believe, in this case
4 by using basically this electronic apparatus in
5 conjunction with the spatial light modulator. It's
6 one of the methods used to produce light.

7 Q. Okay. So a microbeam would be the output
8 from a modulator?

9 A. Among other things based on the
10 description here.

11 Q. Okay. Does the term "microbeam" refer to
12 any type of structure or is it the output of a
13 lighting device?

14 A. Can you clarify? What do you mean
15 structure a beam (phonetic)? I mean, polarization?
16 You mean a phase? You mean second wavelength?

17 Q. Well, let me rephrase. Do you agree that
18 a microbeam is the output of a lighting system?

19 A. Yeah. Um-hum -- or it's a possible
20 output, one of the many ways that we can produce
21 light output.

22 MR. HUGHES: Counsel, we've been going a
23 little over an hour.

24 MR. TURNER: Yes. Let's take a break.
25 Five, ten minutes?

1 MR. HUGHES: Okay.

2 (A break was taken.)

3 BY MR. TURNER:

4 Q. Okay. I'd like to return to the Alden
5 reference, which was Exhibit 1005.

6 A. One main part of the declaration or --
7 I'll do both.

8 Q. Okay. All right. So for Alden, can you
9 turn to figure 5 again?

10 A. Yep.

11 Q. So when we discussed this before, we
12 discussed the 15-degree spread.

13 Do you recall that?

14 A. Yes.

15 Q. Okay. And that 15-degree spread, that was
16 from one of the light elements; is that correct?

17 A. Yeah. Based on the spec -- let's make
18 sure -- yeah. Paragraph 29 it says: "In the
19 illustration, the 125 from 119" -- 119 is the LED --
20 "falls across a 15-degree section of the headlight
21 distribution area."

22 Q. Okay. So if that's one light element that
23 provides a 15-degree segment, what is the total
24 spread from all of the light elements shown in figure
25 5?

1 A. Again, this is a slice, so this is a
2 three-dimensional structure, Number 1. Number 2, it
3 says: "Each other lighting element similarly falls
4 within a defined area of the light distribution
5 area." So it's just depending on the figure 3, the
6 logic in figure 4, and how these are placed on the
7 curve.

8 This is going to be different. And we're
9 talking about, again, 3-D structure as it corresponds
10 to the headlight.

11 Q. Okay. So the light elements that are
12 shown in figure 15, what is the total beam spread?

13 MR. HUGHES: Objection. Form.

14 A. As I said, this is a high-level diagram.
15 So it just illustrates how this whole headlight with
16 controllable LEDs work. So it will be speculation to
17 say that this is exact because this is a high-level
18 concept diagram.

19 BY MR. TURNER:

20 Q. Okay. So based on your analysis in
21 reviewing the challenge claims in view of Alden, what
22 is your opinion on the total beam spread as described
23 in Alden?

24 A. I will go with what he says, paragraph 2:
25 "The result is an automated headlight system which

1 enables the driver of a vehicle so equipped to see
2 optimally, while concurrently the driver of an
3 oncoming (inaudible) can -- also can see optimally.

4 In other words, depending on the scenario
5 and depending on what we have on figure 3 on
6 elements, left sensor, right sensor, and through the
7 logic and CPU, which is described in figure 4, how
8 they select the elements, the shadowed areas,
9 basically, you have the whole system of Alden in its
10 totality.

11 Q. Okay. So does the figure 3 description
12 affect the total beam spread of the figure 5
13 embodiment?

14 A. The figure 3 can inform. But, again, this
15 is a concept. So if you look at the number of rows
16 on 77 and 79, it's not clear how many. Assuming that
17 each element controls one LED, it's not clear and I
18 cannot count here.

19 Q. I'm sorry. What were you just referring
20 to?

21 A. Do you see 77?

22 Q. In figure 3?

23 A. In figure 3. It's a reference as an array
24 matrix. In other words, there are rows and columns.
25 So here basically the disclosure is that each one of

1 these controls one LED. And this is what the POSITA
2 would understand at that time.

3 So it doesn't give me any information how
4 many rows, how many columns we have. It's a concept
5 diagram. There are no dimensions, no scale.

6 Q. So you're saying from the figure 3
7 embodiment --

8 A. It's not really an embodiment. It doesn't
9 mention this as an embodiment.

10 Q. Okay. So is this a sensor array in --

11 A. The sensor array is the 14 -- is the 51a,
12 51b.

13 Q. 51a and 51b. So are you saying that for
14 each sensor there's an associated LED?

15 A. No. This is not what I said. If you look
16 at figure 4, we have the information that is
17 extracted through thresholding from figure 4 elements
18 89, 91, and then 93, 95.

19 Then we compile a left sensor map and we
20 compile a right sensor map. We compare the left with
21 the right. Then through the use of memory we
22 calculate the distance of each threshold object.

23 I need to mention here that the figure 4
24 discloses something quite important and interesting,
25 that they move from lights -- thresholding lights to

1 objects, and then calculate distance of each
2 thresholding object using triangulation, calculate
3 the headlight dim zones for each threshold object,
4 and switch -- this is the part that goes -- that
5 informs 77 and 79, requisite headlight segments to
6 dim; switch other segments to high beam.

7 So, basically, if we go -- I had one
8 figure highlighted -- let me find it -- figure 3. So
9 if you go paragraph 85, page 63 on the 01039 -- so
10 the yellow area is the high beam, which is in the
11 broader field above and below left and right of the
12 area where are the headlights and the driver plus
13 this expanded box remains, and then the other area is
14 dim.

15 But -- so you see we have to see all this
16 intertwined. This is the process. This is the logic
17 that describes the pattern recognition or the object
18 recognition, and then the figure 5 actually shows you
19 the LEDs.

20 Q. All right. So back to the figure 25
21 embodiment. Do these beams overlap? Do each segment
22 overlap?

23 MR. HUGHES: Objection. Vague. Compound.

24 A. From the diagram -- I will only speculate
25 from this diagram.

1 BY MR. TURNER:

2 Q. Okay. So, in your opinion, do the beams
3 overlap?

4 A. Again, I don't want to speculate on this
5 one because I don't have the exact distance between
6 the LEDs, the placement of LEDs, the angle, the
7 curvature associated with this curve that we see
8 here.

9 Q. So is it your opinion that without all
10 this additional information a person of ordinary
11 skill in the art would not understand the shape of
12 the beam pattern from the Alden reference?

13 A. No. I disagree with this. I think that
14 is a very clear concept that goes from headlights,
15 cameras, sensors to CPU logic, which is described in
16 figure 4, and then having controller LEDs which are
17 going to direct the light in areas where we need the
18 light, or in areas where we want to reduce the glare
19 we're going to dim them.

20 So I think a POSITA -- I was asked to
21 opine how a POSITA would look at these documents and
22 this prior art. So I think this is -- this is what
23 Alden teaches us.

24 Q. So does Alden teach to a person of
25 ordinary skill in the art what the output beam

1 pattern is from the figure 5 embodiment?

2 A. I think it teaches you that basically you
3 have one sensor associated with the left headlight,
4 one right sensor associated with the right headlight.

5 Then as soon as the system detects the
6 logic and CPU as the cameras, these sensors, register
7 lights through the flow which is described in figure
8 4, we can basically follow these steps, create these
9 sensor maps, which are basically the images.

10 We can through pattern recognition
11 calculate the object, calculate the distance of the
12 object through triangulation, and then calculate the
13 headlight dim zones for this thresholding object and
14 then we can switch the requisite headlight segments
15 dim, if this is in autonomous mode, or basically the
16 driver can select the manual dimmer switch in the use
17 case of headlights at minimum glare and maximum
18 visibility for the driver.

19 Q. So in the scenario when there's not any
20 vehicles present -- so this is not a dim condition --
21 would the beams -- the output beams in the figure 5
22 embodiment overlap?

23 A. I think my answer, again, would be
24 speculation because the issue there is not so much --
25 as I mentioned earlier, there are a lot of parameters

1 which -- there are several parameters that come into
2 play: How many LEDs? What is the angle, the
3 curvature of the -- and then the existence or
4 nonexistence of a vehicle or vehicles. Because, in
5 particular, Alden discloses that it can detect
6 multiple vehicles and have multiple dimming zones.

7 It can influence a lot of these optics or
8 the impact of optics as we sense the environment.

9 Q. So what is the shape of the lens 121 in
10 the figure 5 embodiment?

11 A. It's the headlight lens that focus the
12 light basically.

13 Q. Okay. What is the shape of the headlight
14 lens that focuses the light?

15 A. With respect to convex? concave? The way
16 I see this is actually more like a convex. But,
17 again, it's pure speculation because this is at a
18 higher level.

19 Q. So the lens illustrated in figure 5, which
20 is 121, that's a convex shape?

21 MR. HUGHES: Objection to the extent it
22 mischaracterizes his testimony.

23 A. I say this is pure speculation, and I
24 don't want to do this. So I would say with extreme
25 caution that there is a possibility that this is a

1 convex lens.

2 BY MR. TURNER:

3 Q. Okay.

4 A. But just to give you the infinite
5 possibilities, it may be a polycarbonate headlight
6 cover that may have different characteristics but
7 still act as a lens. A polycarbonate lens with
8 different segments may follow this category. So
9 that's why I say that this is pure speculation.

10 Q. All right. And how about the LED array?
11 What is the shape of the LED array that's shown in
12 figure 5?

13 A. As I mentioned, the disclosure basically
14 is -- "The 119 and other lighting elements are on a
15 curve along the focal point of a headlight lens 121
16 such that the light from each lighting element goes
17 into a specified portion (or portions) of the
18 legality distribution area.

19 Element emitted light 125 being an example
20 of an element's light being directed into one sector
21 of the light distribution area."

22 Q. Okay. So you said the light elements are
23 on a curve. So what shape would that be?

24 A. This is not what I say. This is what the
25 spec says.

1 Q. Okay. But you're giving us your opinion
2 on what the spec discloses, right?

3 A. My opinion -- I was asked to opine if the
4 elements of the particular claims basically were
5 anticipated, and this is what I opined. And I can
6 read you from my declaration.

7 Q. Okay. So what would be the
8 three-dimensional shape of this array that's shown in
9 figure 5?

10 A. If we take the slice, again, at the
11 conceptual level, it's going to be something that
12 corresponds to the figure 4 -- to the figure 3 that
13 we have, which is an array matrix of LED elements,
14 each one controlled by each control switch that
15 corresponds to the particular location coordinate
16 where the light has been detected.

17 Q. So figure 5 shows one row of LEDs. Are
18 you saying there would be multiple rows stacked on
19 top of each other?

20 A. Can you repeat the question?

21 Q. So for figure 5 it shows one group of
22 light elements 119 that are formed along a curve; is
23 that correct?

24 A. Yes.

25 Q. Okay. So if this is a section, what is --

1 what is below this section of light elements?

2 A. So they will be multiple -- so think of
3 stacks of this section that are going to form the --
4 basically, the array of LED elements that corresponds
5 to this control switch which is shown in figure 3,
6 the element 77 and 79.

7 Q. So do these stacks follow the same curve?

8 A. I think they will follow. They will be on
9 the curve in order to maximize the visibility for the
10 driver in reducing glare. I think I read earlier a
11 statement. I can go back. But a POSITA would have
12 known how to place these on this curve in order to
13 maximize visibility and non-glare for the oncoming or
14 the drivers who are proceeding.

15 And we shouldn't forget the second
16 application which is actually around the curve. So
17 around the curve we may want to have LEDs on the
18 sides that are going to be activated when we want to
19 highlight the curvature up and down.

20 So, again, if you look at this idea that
21 this -- I believe it's called ADB standard, adaptive,
22 I believe, driving beam or something like that.

23 It was approved recently to come to the
24 U.S. But this is a matrix of elements. It was
25 demonstrated in Europe by Lexus years back, and

1 slowly we see it in cars here.

2 So I think that's -- that's what POSITA
3 Alden in its -- based on the specific statements that
4 they have included, this is what it discloses.

5 Q. Okay. So you referenced the ADB, I think
6 you said, standard; is that correct?

7 A. Yes.

8 Q. So is it your opinion that the Alden
9 design, Alden reference, is based on this ADB
10 standard?

11 A. No. That's not what I said. I said if we
12 want to see the trend -- so let's go back to the
13 history a little bit of headlights.

14 As I told you, I have worked all these
15 years with automotive system and intelligent
16 vehicles. So we go back to the Tucker, T-U-C-K-E-R,
17 cars. So this is one of the first ones that
18 introduce some standards for headlights. Then there
19 was a lot of discussion about how we can make these
20 safer, more effective.

21 Then -- I may have the years wrong --
22 excuse me. It's getting late. So somehow at the
23 beginning of 2000 The National Highway board started
24 a three-phase effort -- I don't recall the name --
25 basically, how we can change this; how we can improve

1 this.

2 In the meantime, in Europe Audi and then
3 BMW and I believe Volkswagen created another
4 committee to look at the ADB standard which stands
5 for, I believe, adaptive driving beam or something
6 like that.

7 So the U.S. is so fragmented until very
8 recently that states, for example, have power. If
9 you look, for example, the state of California has a
10 standard about the luminance associated with
11 headlights which is completely different than the
12 standard that we have in Minnesota. The Minnesota
13 (inaudible) has a different one.

14 Not only this, but there are different
15 operating environments. The beginning -- I think
16 until COVID the matrix LED and ADB standard was not
17 allowed because basically the -- so, if I understand
18 correctly, the main objection of the Federal
19 Government was actually we need to have high beams
20 and low beams.

21 By the middle of COVID I believe that cars
22 like this are allowed in the U.S., but I think -- I
23 know of a few models and we start seeing more. But
24 the idea is that you don't have -- you have a matrix
25 of LEDs and basically you can do some very

1 interesting things.

2 And this is the new generation of lights.
3 I mean, my advisor at the project at Carnegie Mellon
4 University -- they have a project of a pickup truck
5 with intelligent headlights where they were having
6 special modulators and LEDs and fans. The problem is
7 that you need to conduct the heat. You need to
8 remove the heat for the headlight.

9 Q. All right. So if we can return back to
10 the shape of LED array in figure 5, is there -- if
11 these are multiple stacks or multiple rows of LEDs,
12 would they be uniform in shape between one stack and
13 an adjacent stack?

14 A. It can be many variations. I mean, you
15 can have, for example -- I will give you an example.
16 You can have an LED with a spherical cover that may
17 give you more -- better visibility on the corner.

18 So depending on the task at hand -- so,
19 for example, you can put -- let's suppose you are in
20 a turning situation and you want to highlight the
21 reflectors more, you can have different type of LEDs
22 as long as all of them are controllable.

23 Once you consider how you are going to
24 cool these -- I mean, the use of aluminum as part of
25 the material is -- actually, aluminum is a very good

1 conductor so it can take the heat out.

2 So a POSITA will have had enough
3 information in order to start designing -- I mean, if
4 I look at the Lexus system that probably is the first
5 one that introduced LEDs in a commercial car in 2003,
6 2004 roughly.

7 And if you look at the Audi system they're
8 basically -- they have different operational
9 characteristics because in Europe the height of
10 headlights is something that is heavily regulated.
11 It's not the same in the U.S.

12 So all of these constraints there will be
13 parts of a POSITA knowledge in order to design a
14 vehicle's headlights. And if I can mention another
15 example, LEDs in general are 90 percent more
16 efficient than incandescent light. The problem is
17 they are also far better to resisting vibrations.

18 However, one should consider specialized
19 buses and processors for these lights -- data buses
20 and processors in order basically to implement these
21 logics that we have been discussing now.

22 Now, when you have a bus some of the
23 dangers you have -- you may have a cyber attack or a
24 security issue with a processor that runs your
25 headlights or LEDs.

1 Q. Okay. So you mentioned that the LED array
2 of Alden could be a spherical shape; is that correct?

3 A. Among other things. Again, it's a
4 different design -- this may be different for a car
5 that sits low like Porsche, for example.

6 I have seen a Porsche take on (phonetic)
7 that's very low versus a truck like a Dodge Ram that
8 is high, because if we want to see over the hill a
9 car that sits very low may have different
10 requirements.

11 MR. TURNER: Okay. I'm all set. Do you
12 guys want to break?

13 MR. HUGHES: We'll take just a few
14 minutes.

15 (A break was taken.)

16 MR. HUGHES: We don't have anything.

17 THE REPORTER: Reading and signing?

18 MR. HUGHES: Reading and signing, yes.

19 THE REPORTER: Would you like a copy, Mr.
20 Hughes?

21 MR. HUGHES: Yes, please.

22 THE REPORTER: eTran, hardcopy, or both?

23 MR. HUGHES: An eCopy is fine.

24 MR. TURNER: Electronic is fine.

25 THE REPORTER: Did you need a rough, Mr.

1 Hughes?

2 MR. HUGHES: Yes, please.

3 MR. TURNER: Rough, please, also.

4 THE REPORTER: Regular delivery?

5 MR. HUGHES: If we can get the rough, and
6 regular delivery is fine.

7 (Signature having not been waived, the
8 deposition of Dr. Nikolaos Papanikolopoulos was
9 concluded at 3:44 p.m.)

CERTIFICATE OF WITNESS

I, DR. NIKOLAOS PAPANIKOLOPOULOS, do hereby
declare under penalty of perjury that I have read the
entire foregoing transcript of my deposition
testimony, or the same has been read to me, and
certify that it is a true, correct, and complete
transcript of my testimony given on Monday, October
16, 2023, save and except for changes and/or
corrections, if any, as indicated by me on the
attached Errata Sheet, with the understanding that I
offer these changes and/or corrections as if still
under oath.

_____ I have made corrections to my deposition.

_____ I have NOT made any changes to my deposition.

Signed

DR. NIKOLAOS PAPANIKOLOPOULOS

Dated this _____ day of _____ of 20____.

ERRATA SHEET

Deposition of: DR. NIKOLAOS PAPANIKOLOPOULOS

Date taken: February 23, 2024

Case: Mercedes-Benz USA, LLC v. Yechezkal Evan Spero

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24 **Signed** _____

25 **Dated** _____

REPORTER CERTIFICATE

WASHINGTON, DC

I, Sherry L. Brooks, a Notary Public within and for the Jurisdiction aforesaid, do hereby certify that the foregoing deposition of DR. NIKOLAOS PAPANIKOLOPOULOS appeared before me on Friday, February 23, 2024, pursuant to notice, at the time and place indicated; that said deponent was by me duly sworn to tell the truth, the whole truth, and nothing but the truth; that the testimony of said deponent was correctly recorded by machine shorthand by me and thereafter transcribed under my supervision with computer-aided transcription; that the deposition is a true record of the testimony given by the witness; and that I am neither of counsel nor kin to any party in said action, nor interested in the outcome thereof.

IN WITNESS WHEREOF, I have hereunto set my hand and official seal this 1st day of March 2024.

Sherry Brooks

SHERRY L. BROOKS, CLR and Notary Public

Commission Expires: November 30, 2025

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