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

CASE IPR 2020-00476
U.S. Patent No. 9,198,565

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SAMSUNG ELECTRONICS CO., LTD, and SAMSUNG ELECTRONICS AMERICA, INC.,

Petitioners,

v.

CELLECT, LLC,

Patent Owner.

----------X

CONFIDENTIAL DEPOSITION

VIA ZOOM VIDEOCONFERENCING

OF

DEAN NEIKIRK, PH.D.

Wednesday, September 30, 2020

Reported By:

LINDA J. GREENSTEIN

JOB NO. 1038

CONFIDENTIAL - DEAN NEIKIRK, PH.D.

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CONFIDENTIAL - DEAN NEIKIRK, PH.D.
September 30, 2020
11:11 A.M. EST

Confidential Deposition held via Zoom Videoconferencing of Dean Neikirk, Ph.D., taken by Respective Parties, before Linda J. Greenstein, a Certified Shorthand Reporter and Notary Public of the State of New York.

CONFIDENTIAL - DEAN NEIKIRK, PH.D.

A P P E A R A N C E S:
(All parties appearing via Zoom Videoconferencing)

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THE COURT REPORTER: Good morning.

We're here in the Matter of Samsung versus Cellect.

Today is Wednesday, September 30, 2020.

Counsel, do you agree that the witness will be sworn today remotely?

MR. CAPLAN: I do. It's fine. I'm with Cellect.

MR. DAVIS: Yes, this is Jim Davis for the Samsung petitioners.

MR. CAPLAN: Good morning, Dr. Neikirk.

Again, my name is Jonathan Caplan of Kramer Levin. We represent Cellect in this IPR proceeding.

Just one administrative kind of issue I'll just raise with Jim, just at the outset.

There's going to be, some of these topics kind of are common across the different proceedings, background and other things, so instead of going through it each

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time, I assume the common lines of questioning we'll use across as opposed to going through background and the same issues multiple times, so I assume that's okay with you? It will also make things shorter.

MR. DAVIS: Yes.

MR. CAPLAN: Great.

DEAN NEIKIRK, PH.D.,
having been first duly sworn, was examined and testified as follows:
EXAMINATION BY
MR. CAPLAN:

Q. It's a little different doing this by Zoom, Dr. Nikirk, just, again, as it's more of an administrative issue for you, generally we'll go about an hour.

If you need to take a break at any time prior to that, just let us know, that's not an issue. But normally we'll certainly take a break at least once an hour.

Just for the record, Dr. Neikirk, is that how you pronounce it,

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"Neikirk"?

A. Yes, that is correct.

Q. Okay. Just can you state your full name for the record and where you currently reside and then work.

A. My name is Dean Paul Neikirk and I reside in Dripping Springs, Texas and I work at the University of Texas at Austin.

Q. Okay. Starting with your background a little bit, you have a Bachelor's and a Master's and a Ph.D.; is that right?

A. Yes, that is correct.

Q. Okay. I'm just going to go through to get a little understanding of your background some more.

Your Bachelor's degree, can you just describe what your focus was as an undergrad.

A. My Bachelor's degree was in physics from Oklahoma State University.

I also have sort of as a byproduct of doing that a degree in mathematics.

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My university specialty in terms of physics was solid-state physics, and I did do research as an undergraduate of optical effects in solid-state materials.

Q. And what kind of -- can you give a little more of a description of kind of what that subject matter was about.

A. As an undergraduate, I worked on what are called stoichiometric-laser host materials. This was a long time ago and lasers were pretty new.

And we were looking at how you get energy into a crystal and how it comes out as a light.

Q. Again, that was part of your undergraduate coursework, so did you do any kind of a capstone or research project as part of that?

A. So in our physics curriculum we have numerous laboratories all the way from basic introductory physics to electronics and so on.

My -- essentially, my capstone research project was working in a research

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lab for a faculty member and publishing as a result of that work I think two journal articles.

Q. And what were the articles about?

A. Again, they were about the laser host materials.

Q. And did any of that undergrad research, which I know is a little bit of a few years ago, was that related to imager technology, things with pixel arrays in it?

A. So I did a full year of electromagnetics and a half a year of optics.

At the time -- so this is, again, in late '70s -- there weren't a whole lot of pixelated imaging arrays around. And that wasn't part of our coursework. I did do that work as a graduate student, but not as an undergraduate.

Q. I want to talk about that briefly because you have a Master's degree from California Institute of Technology.

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Can you tell me what that was about, what the focus of your studies were for that degree?

A. So at Caltech, where I was a graduate student, you were admitted to pursue a Ph.D. degree.

Along the way, by completing the appropriate coursework, you receive a Master's, so the Master's itself is really coursework-based. *

I was in applied physics and our focus included some numerous areas of fundamental physics, as well as electromagnetics and solid-state physics.

Q. Did you work on a particular type of product or problem in that undergraduate coursework or was it more broad-based? *

A. So are you asking about my graduate coursework?

Q. Yes, the Master's coursework.

A. The Master's, we are covering fundamentals. I was already conducting research, again, initially in optical

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properties and materials, and then specifically the design, fabrication and testing of imaging arrays.

That work I would really characterize that as my Ph.D. work rather than my Master's work.

Q. I think you just mentioned the optical properties and materials.

What in particular are you talking about in that area?

A. So, again, given in that time frame, I worked with a faculty member who is called a chemical physicist.

Ultimately, he was a Nobel laureate some years later in chemistry.

We were trying to understand better how light is captured or interacts with sounds, and then how that light -- the energy that light produces in the solids, ultimately is emitted by those solids, so it's a study of fluorescents, phosphorescence and energy transfer.

I don't know -- that's a moderately technical version of it, but it

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would be a little bit harder to rephrase it. Those are the terms of the field.

Q. And was that in connection with devices that were capturing images for display or more just about the transfer of energy between the photons and the material?

A. So I did both.

Initially, I was doing work really on the transfer of energy in a solid under the supervision of a chemistry faculty member.

I changed to another research group under the supervision of an electrical engineer, and in that group I actually built imaging arrays.

So they were arrays specifically to capture electromagnetic radiation and form and image.

Q. Were they particular types of arrays, I mean in terms of -- and on this case we were talking about certain types of arrays, but in that work you're just describing, were those particular types of

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arrays?

A. Yes, they were, and we were interested in a region of the electromagnetic spectrum called the millimeter and submillimeter region.

This is also frequently called the far infrared, and those are terms we used back then. Nowadays they call it terahertz, but we were interested in capturing those wavelengths.

To do that requires the use of antennas coupled to a solid-state detector, so I was designing and fabricating the antennas.

I was also designing and fabricating the detecters that those antennas coupled to and then placing that in an overall electronic system that allowed us to capture data from many antennas, pixels, and the kind of parlance we use here, to form an image.

Those happen to be what were called line arrays, so it was a linear array of antennas. To get the second

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dimension in the image you used what are called scanning optics.

Q. And that coursework and those studies I believe you explained were on the pathway to getting your Ph.D.; is that right?

A. Yes, that's correct.

Q. So were there other areas you studied or what did you do from that point through your Ph.D. studies or research?

A. Well, that was my research, so I was making use of the teachings from my graduate instructors in solid state and electromagnetics and using that to come up with new ideas for antennas, those are the electromagnetic structures, and the detecters. I happened to work on what are called microbolometers.

Combining all that with actually building this, so in order to do this I had to put together an IC -- integrated circuit fabrication laboratory.

I was my advisor's first graduate student, and his background was in

actually building things at Berkeley, where they had an established microfabrication facility. We built our own at Caltech, and that was primarily one of my responsibilities.

So in order to do that, I had to learn all about microlithography, depositions, chemical vapor deposition, physical vapor deposition. All of those assorted topics that are related to actually building integrated circuits.

Q. So what would be some of the applications or products that these antennas and detecters were working on would be -- would it be applications that they would be used for or products that they would be incorporated into?

A. So the work that I did was, I had a very specific application. It was used to do electron density measurements in tokamak plasma. So a tokamak is a type of magnetically confined fusion reactor, which was being investigated for use for fusion, energy generation.

In order to measure the density of electrons in that plasma, we had to come up with a new technique, and that's what the imaging arrays were for.

More broadly, these wavelengths are of interest -- were of interest to the military, for instance, because they penetrate smoke and fog, and so there was a lot of interest in using it for doing imaging -- in environments where normal optical imaging devices don't function well.

MR. CAPLAN: I'm sorry. I just want to check with the court reporter to make sure she's able to hear everything. You were breaking up a little bit.

(Discussion held off the record.)

THE WITNESS: I was looking at my Internet connection. I think it's still fine.

If my microphone does start to break up, please let me know because I can't tell from this end.

MR. CAPLAN: Okay. That's fine.

BY MR. CAPLAN:

Q. And in the course of those Ph.D. studies, did you make any actual products?

A. Well, I made many arrays, which I then supplied to other users.

Whether you call that a product or not, it wasn't work for sale, so -- it was a product in the sense that what I built had to be functional and ready to use by someone else, and I delivered many of those to other laboratories for their use.

Personally, I'm not sure I'd call that a product, but it's certainly related.

Q. Okay. And you mentioned you were involved with fabrication in some of these products that you were working on; right?

A. Yes, that's correct.

Q. And that was done -- well, I just want to make sure, I'd like to understand a little bit better what kind of fabrication, where was it being done and

what kind of a fab process were you working with at that time.

A. So it was being done in the laboratory that I built and it was being done by me, so I actually obtained, to do photolithography, which is one of the steps you need, a mask liner is one of the pieces of equipment.

I obtained three surplus mask liners from IBM, disassembled them to put together one that worked, and so I was using a mask liner that I made work and maintained myself. Put together the laminar flow clean room apparatus necessary to allow us to apply photoresist, to expose it with mask liner, to do the mask alignments themselves.

We built our own masks, so we used a very, by today's standards, archaic technique called rubilith, where we cut our rubilith and did photographic production. I did all of that myself.

So I was intimately involved in everything from the on-paper design to the

generation of masks to the photolithography, followed by the deposition of numerous -- I use mostly metals. I built three different what are called physical vapor deposition apparati to do that.

I also used a number of dielectrics to protect the materials and then assembled the whole thing into a package, so I was responsible for the wire bonding, and that means I did the wire bonding to put it into the package.

So really -- I don't know -- soup-to-nuts, it was basically everything from designing it on paper to producing something that I could hand to another user and expect that they would be able to use it and it would work.

Q. It sounds like that was a pretty customized fabrication process that was tailored for your particular needs at the time.

A. Yes, it was. I mean, every fabrication process in some sense -- well,

it's always tailored to what it is you're trying to make.

Q. And those projects you were working with your Ph.D. studies, you wouldn't characterize those as trying to design and build a charge-coupled device or CCD image sensor, would you?

A. No, those were not CCDs. Those were microbolometer arrays. Different type of sensor.

Q. Separate from your Ph.D. studies now, what other kind of sensors have you worked on? We'll kind of go in sequence.

Once you got your Ph.D., was there a focus of your work as a post-doc in academia?

A. So I did not do post-doc. I went direct from my graduate studies to being an assistant professor at the University of Texas at Austin.

At the University of Texas, I was the second member of what's called the Microelectronics Research Center at the time. Our general focus was to do research

in the area of solid-state devices ranging from microwave to optical devices.

I did a lot of work on far infrared and infrared sensors, so I did continue work for my graduate -- sort of an extension of my graduate work, looking at different types of infrared sensors.

I worked with the techniques used to make those, including molecular beam epitaxy, which is a crystal growth technique, which my group focused on of the use of that to build microwave and higher frequency devices.

The other students in our group worked primarily on laser diodes, so they worked on optical devices.

Over the years from that point I've continued that work on infrared sensors. I've also done a great deal of work on many other kinds of sensors, including acoustic ones, pressure transducers. Chemical sensors was a large focus of my research in the mid '90s to mid 2000s, that primarily for medical

diagnostics.

Q. So the mid '90s, so you were working mostly with chemical sensors, you were saying, in that time period?

A. In the mid '90s -- I'm sorry, I talked over you.

Could you please give me your question again.

Q. I just want to understand, I think you were saying in the mid '90s you were working on a particular type of sensor technology, and I think you said it was chemical sensors?

A. That was one of the focuses of my group.

At that time some of my students were working on what is called interconnects and interconnect modeling for use in integrated circuit design.

Other of my students were working on infrared sensors, which were focal point array devices.

And other of my students were working on chemical sensing. That involved

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what's called micromachining and microfluidics works, a lot of our work done in collaboration with a number of chemists.

Q. In that time period, in the mid '90s, were you working on CCD imagers, the charge-coupled device, that type of sensor?

A. So the type of -- the wavelengths that we were interested in are very long and CCDs will not work. Photo diodes will not work because the photon energy is far too small.

We certainly looked at types of CCDs, which are called -- that the material required for that is mercury cadmium telluride, MerCadTel.

That's -- you are able to build something that is a the infrared equivalent of a CCD that works at about 10 microns. That was something that we made sure we understood as a background area.

We did not do new research ourselves in that area because we were interested in wavelengths where -- even longer wavelengths where MerCad Telluride

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simply would not work. So we were temporarily interested in what are called microbial metric detecters.

Q. I'm not sure if I understood that last term. It looks like "microbial metric detecters"?

A. Yes. I'm sorry, yes. That's the word. It's from microbolometer.

Q. I know I asked you about the -- this really wasn't in the CCD area, but it sounds like it was not also related to the CMOS imager technology at that time either, in that period, that mid '90s period; is that right?

A. Yeah, in that time period and still today. None of the conventional semiconductors photo diode or photo generation is really the key.

In both the CCD and the CMOS-type detector array you have to have light with enough energy to create electron whole pairs, and we were interested in light of such low energy that you simply cannot do that. So we were not directly

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working on those kind of photo detecters.

We occasionally did use some with our molecular beam epitaxy system.

(Reporter clarification.)

A. We did use those. It was the molecular beam epitaxy, and for short I'll use the acronym MBE -- simpler -- but that's the acronym.

Our MBE systems were particularly well-suited for depositing very thin layers of compound semiconductors, which are very useful for both photo sensing and photo generation, so both for laser diodes, to produce light, and photo diodes, to receive light, we did on occasion do testing on those sorts of things.

The advantage of that material system is what's called a direct band gap semiconductor. So it's more efficient than silicon. It has disadvantages in that it's harder to work with and it's more expensive.

Q. Okay. I appreciate that.

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So just I'm clear, I think it was clear, but so in that mid 90s period, the focus of your research and your oversight in academia was not on CCD imagers; is that right?

MR. CAPLAN: Object to the form.

A. I think it's fair to say that the focus -- I had more than one focus -- the foci of my research was not on CCD specifically.

Q. And the same question in connection with CMOS: That was also not a focus of your work at that time; is that right?

MR. CAPLAN: Same objection.

A. Well, so as to CMOS -- actually, one of the prongs of my research group was developing models of interconnects to be used primarily in MOS integrated circuits, so it was for CMOS.

In my coursework, I taught a laboratory course where we built CMOS devices, but the CMOS, for instance, active pixels, that was not a focus of my own

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research group's work.

Q. Okay. I appreciate that.

I did take a look at your CV so it's not a quiz, and obviously I believe you have your declaration, I was going to say your report, but your declaration in this IPR, so if any of these questions -- it's not a memory test, if you need to look at anything, just let me know. That's obviously fine.

Did you work in industry, though? Obviously you have quite a career in academia. Have you worked in industry at all?

A. I have worked with industry extensively, but I would not say I worked in industry.

I have been a full-time academic for my entire career, but a great deal of my research was very applied and was either of interest to the semiconductor industry or to the Department of Defense, but by the '90s -- I'm trying to remember the time frame -- probably mid 90s and into the

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2000s, one of the major prongs of my research was really driven by the needs of the silicon world.

So the silicon fabrication businesses, Motorola, AMD. I did research work for Sematech, which was a research consortium for semiconductor manufacturing.

So in that environment, I was working quite closely with my industry partners, but I was not on their payroll.

MR. CAPLAN: I'm sorry, you know what? I really hate to do this. I'm having some medical issues in my family. Can we take a short break?

MR. DAVIS: No problem.

(A recess was taken.)

BY MR. CAPLAN:

Q. Dr. Neikirk, again, I apologize, I had to take a brief break there, but you were going over some of your work with industry as opposed to in industry, and you mentioned a couple of companies, and that was actually one of the questions I had for you.

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When you said you worked with industry, I just want to get a sense of what particular companies you were working with at that time, and I assume we're still talking in this mid '90s time period, if that's correct.

A. Mid '90s stretching into the 2000s.

Q. And so what companies were you working with at that time?

A. So the very active members in the research field that I was working with included Motorola and IBM. I was in fairly close contact with a number of people at IBM, T.J. Watson Research Center primarily, but Al Rhueli and a few other people at IBM.

Similarly, people at Motorola.

At that time, some of our models were being incorporated into some of the computer-aided design systems, so we worked a bit with Silvaco and with Mentor Graphics, to some extent with AMD, a number of students ended up going to work at AMD.

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Some of the collaborators were also at Microsoft -- excuse me -- Intel, not Microsoft. Intel.

So those would be ones that come to mind off the top of my head.

Q. And the work with industry was in connection with the same technologies that you described that you were working on in overseeing research for; is that right?

A. Yes. And, in particular, the what's called interconnect modeling and characterization work was of very great interest to those at Intel and IBM and at Motorola, as well as the computer-aided design firms.

Separate from that, some of my sensor work, specifically pressure for the sensor work, was of interest at Motorola. Different research group, or different group of people at Motorola, but that work was also one that we did some collaboration on.

And the infrared sensor work, which was mostly funded and driven by the

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interests of the Department of Defense, but we worked with a company called Foster Miller, which was a defense contractor, on some Small Business Innovation Research grants, SBIR grants. And that was specific to the infrared focal point array work.

Q. And, again, it sounds like your work with industry was not in connection with products or research tied to CCD imager products; is that right?

A. So the interconnect work, I would agree, that's really not related to CCDs, and neither is the pressure transducer work.

As I think I already tried to explain, the infrared focal point work, our primary competition was the mercury cadmium telluride work, which is related to CCDs. It is a photo detector array. But we were looking at alternatives for that, so we had to understand it because it was our competition, but that's not what we were building.

Q. And was that the same -- to the

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extent you were looking at the CCD technology at that time, was that the same CCD technology that was used in commercial consumer products at that time?

A. So the mercury cadmium telluride-type devices were more exotic. They were only used in military systems. They were not based on silicon. They were very expensive. They were occasionally used on telescopes for their infrared response.

The silicon-based CCDs were -- only work for visible wavelengths of light. We were primarily interested in longer wavelengths.

Q. I asked you that question which you were just responding about CCDs, but the same in connection with CMOS:

Your work with industry at that time wasn't in connection with CMOS imager products or CMOS imager sensors, was it?

MR. DAVIS: Object.

Form.

A. I think that it's fair to say

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that the work that we were doing was not directly in the area of CMOS imaging devices or CMOS pixels.

Q. Okay. You've obtained a number of patents; is that right?

A. Yes, that's correct.

Q. It looks like you got them all while you were on the faculty at the University of Texas; is that correct?

A. Yes. All of my patents are assigned to the University of Texas.

Q. It looks like -- I'll ask you, but your patents appear to be in the same technology areas that you've been describing you've been working on; is that right?

A. Yes, I think that's correct, yes.

Q. And we don't have to go through all your patents, that's not the focus here, but the two questions I've been asking I do want to follow up on here, is that it didn't appear -- and do any of your patents relate to CCD imager products or

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CCD image sensors?

A. So the chemical sensing work that we did, most of it was what's called optically transduced, and so we would use imaging arrays, silicon-based, as the photo detecters to capture the signals from our chemical sensors.

But I would say that those patents largely view the image sensor part of it as being conventional and well-known.

It was the chemical interaction with light that was the new focus and ways of assembling that into arrays.

But the final photo detection, which we usually use arrays, frequently CMOS arrays, those, I think -- where they're discussed in the patents, I'm pretty sure they would be discussed as conventional and well-known.

Q. So you wouldn't characterize any of your patents as being CCD imager patents then, would you?

MR. DAVIS: Objection to form.

A. Well, so certainly they were not

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specific to CCD imagers.

They frequently related to imagers or used them, but, no, again, I don't think that the novel aspect for which we obtained the patents was because of the CCD or CMOS, as often as I think we did use CMOS.

Q. And when you talk about imagers, I just want to make sure I understand your understanding of that term "imager."

What are you referring to when you talk about an imager, because I know it's come up a few times? I just want to be clear about that.

A. Broadly speaking, I usually use that word to relate to a system which has to have something to collect light optics, a detector or transducer to convert that light into an electrical system, and then in many cases electronics, to produce a signal that can be otherwise used.

And so an imager, the way I was using it, is frequently that -- all of those things put together.

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Not just the focal point array, which is the term I usually use to talk about the device that has the photo detectors which convert light into an electrical signal.

Q. Okay. So then it sounds like there are a lot of different types of imagers as you use that term.

There are a lot of different technologies which can be employed in an imager, as you've been describing it; is that right?

A. Yes. I think that's fair. There are many different types. All combined, there are different types of focal point arrays, for instance.

Clearly, there are different types of optics and there are different electronic processing done after the light is converted to an electrical signal.

Q. Okay. In terms of manufacturing experience, I know you talked about some of the -- you had a lab and you did some fab work which you were describing in

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connection with your Ph.D. studies.

Have you actually done any CCD imager manufacturing in the course of your career?

A. No, I haven't done specifically CCD fabrication. I worked -- I developed a course on silicon integrated circuit fabrication and taught that course for 25, 30 years, along with a laboratory to actually do it, but we did not do CCD arrays.

Q. And have you done any CMOS image sensor manufacturing in the course of your career?

A. Again, that specific type of detector was not a focus and we did not make those in our teaching class either.

We were primarily focused on things more applicable for digital applications.

Q. What do you mean by that, for digital applications?

A. Well, the primary -- so my teaching course, the graduate students and

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undergraduates in that class were typically being employed by industry, and the vast majority of industry was in fabricating digital CMOS silicon devices.

So our focus was on silicon devices, silicon transistors, and our focus was more the transistor side than the photo detector work. Photo detecters are much more of a niche application.

And so in terms of an education and training environment, we needed to focus on things that the students were most likely going to be employed to do.

Q. Okay. So then it sounds like your focus was not on the photo detector aspect of these different imagers; is that right?

MR. DAVIS: Object to form.

A. So in terms of my teaching, I would say that's correct.

My research, again, was different and primarily focused on infrared photo detecters, which typically are not CMOS, nor are they CCD.

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Q. I know you talked a little bit about CCD technology that was kind of peripherally related to some of the work you were doing, but was there a particular point in time where you became more familiar with CCD imager technology, and I'm talking about an imager which has -- trying to use your language so we're not talking past each other -- a CCD photo detector sensor?

A. So when I was in graduate school, I worked -- one of the groups that I worked with were people in astronomy, and a number of the faculty I worked with, their area of application was astronomical systems.

At that time, the imaging array of choice was a CCD, and I became familiar with them even then, as, if you will, competition, so I had to know what the performance metrics were for a CCD device to understand whether what we were working on could ever perform that well, or preferably perform better.

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So I've been familiar with CCDs since at least the early '80s.

Q. And when you became first familiar with the CCD technology in the early '80s, were you familiar with how CCDs were being manufactured at that time and designed or just how they operated or the results?

A. I would say both. In order to understand how they operate, you also have to understand how they're made.

And, again, you'll recall I've already explained this, that one of my areas that I've always worked in is actual fabrication, so even if I was fabricating infrared devices, I was always interested in keeping myself informed in how people use similar fabrication techniques to make other things, and that would include CCDs.

Q. So you did study CCD image sensor manufacturing?

A. I would say to some extent, yes, I was certainly aware of it.

Q. And that was in your graduate

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studies? Is that when that happened?

A. Well, it wasn't in a formal course. It was -- it was background information I needed to know to be able to put my own work in context, and that continued forever.

I mean, I always need to know what the competition does, how it works, how it's made. I want to understand a different device's advantages and disadvantages.

Q. Okay. So then you would agree then you studied CCD technology, it sounds like it started in the '90s, as background information to your core research which was not on CCD image sensor technology; is that right?

A. I think that's a fair way to describe it, yes.

Q. Okay. And how about CMOS technology? When did you develop an understanding of CMOS technology?

A. Well, of course CMOS is a much broader term, but if you're asking -- are

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you asking specifically about CMOS photo detector architectures?

Q. Yes, let's focus on the CMOS. I should have said that.

So CMOS photo detector technology, when did you become familiar and start to learn about that technology?

A. Well, that technology really didn't even exist in the early '80s, or at least not in any broad-based form.

That was something that really started to develop in the late '80s and early '90s. And I became aware of it at the time, at that time.

The idea of -- the photo diode itself is -- in some of the implementations is, I'll say, conventional.

The idea of incorporating at each pixel storage and addressing circuitry was something that was going on both in that area, CMOS focal planes and the infrared focal planes, which was really more of my interest.

I mentioned I worked on

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microbolometers. To make that a useful imaging product, they had to -- they used CMOS circuitry, which was called a readout IC, ROIC, under the infrared detecters.

And so, again, I was doing research on how to make the detector better, but it was very important for me to understand the other part, which was the CMOS part.

So I would say I became aware of it in the late '80s, early '90s. Again, I had to understand how that was working to put my own work in context or understand how my work might be used in combination with CMOS technology.

Q. Okay. So, again, then your introduction and understanding of CMOS technology evolved as related information -- call it maybe background information -- for other work you were doing, but the focus of your study and research was not on this CMOS image sensor focal point array itself; is that right?

MR. DAVIS: Object to form.

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A. I think that's a reasonable way to describe it. It wasn't the focus of my own new research.

Q. Let's span back when you started learning about the CCD technology.

Were there particular benefits of the technology at that time? What was it about the technology that caused you to need to learn about it?

A. Well, so in the early '80s -- '70s and early '80s, the types of available solid-state focal point arrays, so the solid-state replacement for film, there were few choices, and I'm trying -- CCD was certainly one, and maybe the only one in roughly 1980. I've forgotten what other alternatives there were.

A CCD, when cooled, is -- can be a very sensitive and low noise device, and that was very important for the astronomers.

The people I worked with were working at the observatories in Hawaii. They were interested in observing very

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faint objects, so it was critical that they have high sensitivity and very low noise, and CCDs, that was the device of choice at the time.

Q. And by the time CMOS became a technology that you started hearing about and getting some background on, was there -- what were the differences between those two technologies in terms of how they were starting to be used in the marketplace?

A. Well, broadly, the CCDs -- when the first CMOS imagers came out, they tended to be higher noise, so from a purely electrical performance perspective -- optical and electrical performance perspective, they typically were not as good as CCDs, but they tended to be cheaper.

CMOS was -- the techniques to fabricate CMOS were widely available, and by the mid '90s to late '90s used to build many millions of transistor circuitry. They were pretty cheap.

CCD fabrication, although it's

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still silicon usually, required a slightly different set of processes, and because of that, you're -- you have to -- a fabrication facility is dedicated to basically one style of process.

If you can make many different types of parts that can be used by many, many -- in many, many applications, then essentially you have a manufacturing technique with a big market and that tends to drive costs down.

The CCD processing is a little bit more unique and tends to be one where you're now dedicating that fabrication plant/facility to really just one product and roughly only one sector of application. It tends to make it a bit more expensive.

So I think I said earlier that I work with astronomers. Astronomers' cost was not an issue. Cost was irrelevant. Performance was everything. They didn't use very many CCDs, but they had to be really good and they paid a lot of money for them, and by a lot of money in some

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cases I believe they were tens of thousands to hundreds of thousands of dollars for just photo detecters.

By the '90s, there was a lot of interest in consumer applications, where cost is very important and people were trying very hard to make CCDs cost competitive.

But one of the big promises of the CMOS imagers was they could say -- and early on, there wasn't a market yet, so they couldn't demonstrate it, but they could say: "We have all of this infrastructure already in place for CMOS, we've already demonstrated it's cheap, CMOS imagers should probably be able to be cheap." And then over the years they demonstrated that.

They also improved the performance to a point where the performance of the CMOS imagers -- focal point arrays -- were certainly adequate for consumer applications or more than adequate.

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And so any advantage you might get from a CCD from a performance perspective really wasn't relevant. Cost was.

So that's roughly how that area evolved. And I follow that fairly closely with a great interest in those areas, focal point arrays, and in the areas of integrated circuit.

Q. The CCD devices you worked on or you looked at in connection with the astronomy applications, those were not in consumer devices; right?

Those were more industrial applications; is that correct?

A. Yes, that's correct. Those -- the CCD arrays used by the astronomers on telescopes, I wouldn't refer to those as consumer products.

Could someone else buy them? Yes. But as I said, they were very expensive, and the average consumer would not be putting them in a camera.

Q. So just based on your testimony

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in the last couple of questions, it sounds like you would agree that at the time, let's talk about the mid '90s, that is a relevant time frame for us, so in the mid '90s, as the CMOS technology was coming to market or becoming more developed, even at that time, in the mid '90s, CCD image sensor quality was higher than the CMOS image sensor quality.

Do you agree with that?

MR. DAVIS: Object to form.

A. From the perspective of pure performance numbers, meaning noise, that was probably still true roughly mid '90s, but it was already clear at that time that for most camera -- consumer camera applications, for instance, that noise level was not a limiting factor for either device.

Again, it depends on what you're going to use things for. If you're taking snapshots, ultimately low noise performance is probably not your driver.

If you're building a military

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system for use on the battlefield, cost is probably not the driver, but performance is.

So I think that was well understood by the -- by the mid '90s, that CMOS worked, it was cheaper and its performance for many applications was good enough, whereas if you went to some other applications where noise was the limiting character but cost was not relevant, you might choose CMOS -- I'm sorry -- you might choose CCD instead.

MR. CAPLAN: Is this a good point if we can take a short break here? Maybe 10 minutes.

(A recess was taken.)

BY MR. CAPLAN:

Q. So, Dr. Neikirk, you were just testifying about some of the differences between the CCD and the CMOS technology in that mid '90s time period and you made a comment about the cost and quality issues, in particular, that CCDs tend to be more expensive to manufacture and the CMOS

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imager pixel arrays were less expensive to manufacture but had a lesser quality result than the CCD image sensors; is that correct?

A. I don't think I used the word "quality." I specifically mentioned noise.

MR. DAVIS: And objection to form.

A. Quality is a much fuzzier metric. Noise is a specific thing.

Q. And if there's a lot of noise in an image, is it harder to see the image clearly compared to an image that has less noise?

A. That's -- that's one way to look at it. It's usually more of an issue for very, very low light level systems.

Q. Okay. And my follow-up question then is, what's the basis for your testimony about the comparison and contrasting of the CCD and the CMOS imager, image sensor? You talked about the photo detector aspect of it in the market at that time.

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A. I'm sorry, you asked me what my basis is?

Q. Yes, the basis.

What's the basis that it's your view that those were the issues and that's how the products are being treated in the marketplace?

Was it just your observation or was it something you had studied? What's the underlying basis for that?

A. My awareness at the time of the issues related to building imaging systems.

Again, as I pointed out, I was working in types of imaging systems, different wavelengths, but it's important to understand the context.

I was also working very actively with those in the fabrication world and understanding the various differences in how fabrication is done for different things was important.

So I would say the basis is my -- I may have some specific citations in my declaration about the technologies in

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general terms, but these issues we've just been discussing is something that I was aware of at the time as -- anybody working in the field of imaging systems needs to be aware of the larger universe than their own narrow slice of that imaging, so it was being aware of the environment I was working in.

Q. And in that environment that you were working in, it was related background reading either on CCD or CMOS photo detector sensors at the time where you were getting your information at that point, because it was not the focus of your research and work at that time; is that right?

A. Right. So it would have been from reading scholarly journal articles and trade magazines. I subscribed to most of -- to numerous of the optics sort of area. Laser Focus, for instance, subscribed to Laser Focus for many, many years -- that was a trade magazine -- so, those.

IEEE Spectrum, which is kind of

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the monthly publication, the IEEE.

So there were lots of places where these topics were being discussed at the time.

Q. Was that a common way that you would keep current with issues in the imager sensor industry, looking at some of these different publications, like Laser Focus or IEEE?

A. I think that's what most scholars do. They read the literature. They attend conferences. I was a regular attendee at SPIE conferences.

There would be sessions dedicated to my own subspecialty of infrared detecters. There would be other sessions dedicated to other types of sensors. I would go to those.

So I think that's just generally what researchers in the field need to do, and especially those in academics.

Q. Okay. Do you have a view as to when -- I'll call it the noise -- I guess the noise issue in CMOS photo detector

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compared to a CCD image detector, when the CMOS caught up to the quality or the noise level of the CCD?

MR. DAVIS: Objection to form.

A. Actually, I'm not sure that they ever have.

There were other -- one of the particular problems with CMOS in the early days was what's called fixed pattern noise.

Also a problem in the sub area -- the infrared detecters that I work in, fixed pattern noise is related to the fact that every -- that your photo detecters don't all have the same response characteristic.

So even if you illuminate the array with a uniform scene, it appears to not be uniform, okay, and that's always the same. That's why it's called fixed-pattern noise.

What the CMOS folks were able to do was to reduce that level to some extent and then also to use various signal processing techniques, which because it was

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CMOS, they could add transistors, if you will, very cheaply. So you could either put the circuitry off the chip or put it on. It makes some difference. The size of the chip would change, cost would change some, but the incremental cost was acceptable. And it produced an imaging array with performance sufficient for many applications.

I am not absolutely sure, but I think to this day if you look at the astronomy world, you'll find that they tend to use cooled CCDs because they have the lowest noise level.

So, I mean, I don't know that CMOS ever outstripped CCDs from this noise perspective, but they certainly did become less expensive and of performance sufficient to support many, many consumer applications; consumer cameras, broadly speaking, for instance.

Q. Okay. There are a lot of applications, industrial applications, it sounds like astronomers and there are

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others.

You would agree, though, that the CMOS photo detector array has become the dominant technology in many of those other industrial applications, maybe not in the Hawaii system, but in other industrial applications.

Would you agree with that?

MR. DAVIS: Object to the form.

A. So it's a very broad question, but I think in general terms, CMOS-based focal point arrays, imaging detecters, are probably -- if you counted up all the applications, they are used in more than CCDs. I think that's probably true.

I haven't tried to do that as an exercise in counting, but I think that's probably true.

Q. All right.

Are you familiar with -- let's talk about in that mid '90s time frame, even into 2000, but let's call it the '94-'95 to '99 time period, are you familiar with who were the major

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manufacturers of CCD, photo detector arrays or CMOS photo detector arrays?

A. You know, I don't recall specific companies -- yeah, I don't recall specific companies. That is quite a while ago.

Q. But also in that same time period, do you have any understanding of the volume of products or the different applications for CCD photo detector arrays and CMOS photo detector arrays in that time period?

A. Well --

MR. DAVIS: Objection to form.

A. Again, I haven't tried to do as -- I don't recall doing a broad-based survey, but there were cameras available to the public, if you will, somewhere in that time frame. I think the earlier ones that you could buy were CCD.

But right in roughly that time frame, some came out that were CMOS. I don't recall specifically what year, and I'm just using cameras that a consumer can

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purchase as kind of my example for that.

Q. And I believe you talked about this already but I just want to confirm.

So it's your understanding, again, in that time period, in that mid '90s time period, that the CMOS photo detector arrays had more noise than the CCD photo detector arrays; is that right?

MR. DAVIS: Object to form.

A. I think for noise, as the characteristic -- characterization, yes, I think that's true, for noise, and of course it depends on the application as to whether the noise mattered.

Q. Are you familiar with the term "on-chip" and "off-chip" in connection with semiconductor manufacturing?

A. Well, on-chip is a fairly descriptive term. It refers to things that are fabricated, and I'm going to use the word monolithically, on the same piece of semiconductor versus things that are not off-chip.

Q. And with respect to CCD image

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sensor and photo detector array technology, again, in this time period, the mid '90s, did that use an off-chip approach to the overall design of those products, do you know?

A. My recollection, and I believe some of the art, as I've discussed in my declaration, the -- including some circuitry on the CCD was done, it varied in terms of how it was partitioned. How much was on-chip and how much was off. I think it varied. It depended on the application and manufacturer, I think.

Q. Are you saying you could put additional circuitry onto the same piece of silicon where the CCD photo detector array was located? Is that your understanding in that time period?

A. Yes, you could, and I believe some did. I'm not sure that -- you know, I don't recall whether they had -- well, you say circuitry.

The CCD itself was a circuit, and, you know, additional circuitry, yes, I

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think some was there and sometimes not. It just depended on the specific application and the manufacturing.

Q. Are you thinking about a particular device or reference or description of a CCD device that has multiple components on the circuit with the CCD photo detector array?

A. Well, I believe, again, I think I mentioned -- if I -- could I find the art...

I think this was background art. It wasn't art that I cited as art in the invalidity analysis, but I cited a number of other articles.

But I think one of the pieces of art I used also cited within itself to a laser focus article. I think that was an Eric Fossum article in which he gave a general background and discussion of CCDs.

He started off with pros and cons and then he talked about the evolving area of CMOS sensors. And that one might be -- I don't recall right off the top of

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my head, but I know I've seen it, and I recall it from the time that it just varies to how much you put on board -- how much you put on-chip, how much you put off-chip.

Q. So what kind of circuitry or components would or could you put on-chip in a CCD photo detector array?

MR. DAVIS: Objection to form.

A. You know, off the top of my head, I don't recall what specific ones were done.

You know, obvious things that may or may not have been included would be the possibility of putting timing and control, some forms of that.

There are many different forms of that form of circuitry. Basically circuitry that assists with the readout.

Remember, a CCD is kind of a bucket per grade readout, which is typically quite different from how you read out CMOS. So peripheral circuitry to help handle that readout may or may not have been included.

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Q. As you sit here today, can you identify a particular reference or product that has other circuitry on-chip with the CCD photo detector array?

A. Off the top of my head, I don't know that I can point you to one specifically.

Q. You mentioned Eric Fossum. Do you know Eric Fossum?

A. I certainly know him by reputation and his field of research. I don't personally know him.

Q. I'm sorry, what -- go ahead.

A. He worked at JPL in the -- I think late '80s, certainly through the '90s. JPL was managed by Caltech, and I used to do some work at JPL when I was a graduate student, so there's sort of a -- there was also an astronomy connection, which is also a connection to NASA. I tended to follow people in work that went on at my old institution, so there was that connection, but I don't know him personally.

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Q. Okay. I believe you said you know he had a reputation.

What was his reputation, at least at that time? And it sounds like we're talking about -- well, we are talking about the mid '90s period.

Do you have an understanding of his reputation at that time?

A. Well, I think that his -- he was at JPL, the Jet Propulsion Laboratory, and the Jet Propulsion Laboratory supported NASA projects, and, in particular, one of the things they supported was map imaging systems for NASA. And I believe Dr. Fossum's work was broadly in the area of supporting the focal point arrays for use in NASA camera systems or telescopes. So I think, you know, I don't recall that -- I don't think he started out with CMOS. I think his broader role was that imaging support. So he would have looked at everything, I would think.

Q. Is it your understanding that Dr. Fossum was a recognized innovator in

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that -- in the CMOS imager photo detector array area?

A. Yes, I think that's fair.

Q. I believe in your report --

MR. CAPLAN: And I know, Jim, you said Dr. Neikirk has his declaration and the exhibits there; is that right?

MR. DAVIS: Yes.

THE WITNESS: I do.

BY MR. CAPLAN:

Q. So there is an Exhibit 1060. It's a Business Week article. Is that something that --

MR. CAPLAN: Jim, just in terms of how we're doing it, I assume we're going to use the IPR exhibit numbers for the deposition?

MR. DAVIS: Yes, that makes sense.

MR. CAPLAN: So I'll just refer to Exhibit 1060.

(Exhibit 1060 for identification, Business Week article, shown to witness.)

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THE WITNESS: I do have that open in front of me.

MR. CAPLAN: Great.

BY MR. CAPLAN:

Q. So this is an article that you cite in your report, or your declaration -- sorry -- Dr. Neikirk?

A. Yes, I do.

Q. Okay. And this article is about the work that Eric Fossum was doing at JPL for NASA; is that right?

A. I believe that is correct. It identifies three inventors from JPL, and they identify Eric Fossum as the leader. This was written in '95, this particular article, yes.

Q. This is a document that you looked at in connection with preparing your declaration in this IPR; is that right?

A. It is.

Q. When you read this article, did you recall if you agreed with it or not, in terms of what it's describing as the state of the art at the time?

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MR. DAVIS: Objection.
Form.

A. So let me scan it again. It's been a while. Largely it's talking about the active pixel sensors and makes reference to costing less than CCDs.

Q. Do you agree with that?

A. I do, in general terms.

"Incorporating" -- to quote from it -- "all manner of electronic controls that are usually on multiple chips."

And again I believe that that was viewed as being easier because it's fundamentally a CMOS technology.

Some of the special processes required for CCD you have to be careful when you mix them with CMOS. It doesn't mean you couldn't, but it tends not to give you the cost advantage.

This particular article said it required less power. I think that's probably, in general terms, fair.

Q. So you agree with that as well then?

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A. I think so.

MR. DAVIS: Objection to form.

A. In general terms.

Q. Just so I understand that, because you said "in general terms" you agree with it, is there some aspect of it that you don't?

A. Well, if you had -- of course it depends on the number of pixels. I mean, I suppose if you built a 100 pixel CCD and a mega pixel CMOS, I don't know how the prices would compare -- would compare, but -- so that's what I mean by "in general."

If you tried to put -- make other things a constant, I think the CMOS would tend -- certainly today it is cheaper because the technology has matured.

Q. That was true at the time of this article too as well, though, wasn't it?

A. Well, I think at the time of this article, it was a discussion of -- more of promise. You know, this was written in '95. You know, there's another

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sentence that says: "Chip offers fresh opportunities to the companies that have been stymied by the high barriers to entering the CCD production."

So I think that this was -- in '95, I think some of these statements were probably ones that fell more in the category that we should be able to do this, and I think they had a reason to be very confident -- confident they would be able to do all of these things.

I don't know which one of these things had been demonstrated by '95, and I think in terms of commercial production I think it was fairly limited.

Remember, for instance, Fossum's own chips, the earlier pieces were done in what's called a foundry, specifically for JPL. That's not a consumer product yet.

Q. In the article, if you're looking -- the beginning of the article it makes reference to -- it says "get ready for the camera-on-a-chip" in the first sentence.

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Do you see that?

A. Yes, I do see that.

Q. Is "camera-on-a-chip" a phrase you were familiar with at that time?

A. That was a phrase that -- and I don't know precisely who coined it. It may have even been Fossum. I don't recall.

But it was a term that was thrown around or began to be used in the early -- I think early '90s, I don't know, maybe it got thrown out in the late '80s.

But, in general, the idea was having as much camera functionality as possible on a single chip.

Now, what actually meets the definition, I don't think there was a definition at the time. I think it was more of a -- a term of promise. You know, by switching to CMOS, we ought to be able to integrate more and more on chip, and so at some point perhaps we have all the functionality we need to have a complete camera on one chip.

Q. I'm just looking at the

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transcript. You said it was because a CMOS detector ray was built using CMOS that you could have this integration, camera-on-a-chip, with all the features integrated on a chip; is that right?

MR. DAVIS: Objection to form.

A. It's a question of process compatibility.

So when you manufacture an integrated circuit you have a certain set of fabrication processes, and those processes have to be -- are developed to make a certain type of devices.

If you've optimized the processes for making MOS transistors, and the only thing you have to use is MOS transistors for whatever your goal is, that means you can probably do it, okay.

For the CMOS pixels, mainly what you build are either CMOS transistors, or depending on the design, a photo diode area, which actually looks like part of a CMOS transistor.

So because of process

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compatibility, yes, you can then take CMOS logic, or whatever, and largely expect you can put it together, and the manufacturing technique will work for all of it.

Q. And that's the ability to do everything in CMOS that is what gave rise to the camera-on-a-chip process being possible?

MR. DAVIS: Objection to form.

A. I'd say that's reasonable, but the -- at least camera-on-a-chip at a more reasonable cost.

It's possible to design a process flow to combine CCD with other things, but it's not a standard process flow.

So the -- I'm trying to think of an analogy. A -- an automobile manufacturing plant is optimized to make one model. Maybe there are options, right, but they make one model.

If you decide to change models, you've got to retool the plan, and that costs money.

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Same thing with types of integrated circuit devices. At this time, in late '80s/early '90s, the idea of what's called standard CMOS process flow was evolving, and things called foundries were coming into existence, which basically would manufacture anybody's design as long as it fit in their process flow.

Trying to combine CCD with generic CMOS logic doesn't really fit that standard process flow, whereas the CMOS pixels did, or do, still do.

And so it was -- I think there's a quote in here from Dr. Fossum himself where he said -- where did he say this? I just noticed it, that they sort of turned it on its head. Where is it -- he talks about since it's made on standard semiconductor production lines. That's what I was just talking about.

Where is that -- somewhere in here he points out that at some point they sort of started to realize, well, rather than staying with the CCD and creating this

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custom fabrication process, maybe they should just say "all right, let's use the standard process and figure out whether we can make a good photo cell, a good pixel," and that's what I think led to the active -- the pixels that they developed, as well as a recognition of their potential, and ultimately that potential has been realized.

Q. So in this Exhibit 1060, where Dr. Fossum is talking about CCD and CMOS devices that he's working with, you would agree that he -- Dr. Fossum's approach was not to combine CCD and CMOS products at that time; right?

A. Well, I mean, actually, I'm not sure that he hadn't already tried that.

I think the -- by this point in time, the -- I'll call it selling point, the -- what they were trying to point out were the advantages of not doing that.

That you can use standard CMOS processing that manufacturers already had, didn't require them to retool, and that's

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that high barrier to entering CCD production language that's in that article.

So I think what he was pointing out is that there may be circumstances where best performance as measured by noise isn't really the right thing you should focus on, and that by going to this technology you could build an imaging chip that had more functionality, but really one of the critical pieces was it cost you less to make that.

I don't think it was so much a statement that it is impossible to do it with CCD. It's just that it costs a lot, and if you didn't already make CCDs, it would cost you a whole lot to get into that business. And I think he says that right there. This article says that.

Q. So the state of the art at the time is, as described in this article, was going to camera-on-a-chip CMOS photo detector array image sensors; is that right?

MR. DAVIS: Object to form.

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A. I think at the time of this article, it was more of a promise than a reality. But, again, I think it was a promise made with a lot of good reasons.

So recognizing that this was a good place to go was an important innovation.

Now, exactly what year, what got incorporated where, you know, exactly how much has to be on-chipped, call it a camera-on-a-chip, those are all -- first of all, I don't recall what years are exactly what, and, you know, one person's camera-on-a-chip might not be somebody else's in terms of functionality on a chip.

But I think in 1995, when this article was published, what they were pointing to Fossum's group at JPL as being key innovators on is recognizing that using standard CMOS processing had a lot of advantages in terms of cost and the ability to combine both the pixel, the imaging sensor and other electronics could be one of great advantage because it doesn't cost

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very much to do that. It's the same process.

I think that that is what, at the time, my recollection of how this evolved, having worked in fabrication for CMOS, I was well aware of foundry processing.

But virtually everything -- all the manufacturers I knew of were doing digital. Nothing analog. There were a few custom analog circuits done by Motorola for sensor products, but they were typically different. And this idea that you could start to do analog using a process you already had was a clever one.

It was: Okay, well, let's go back and look at the circuit design, look at what you're able to do with the standard process and see what circuits we could build that we didn't used to try.

One of my own graduate students, we wanted to build an analog processing unit to measure some specific analog signals. And we wanted to use a standard

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process, but the process available to us was digital CMOS.

So using this philosophy, we simply sat down and said: Well, gee, can we use that process to build what we want.

We could. It ended up with kind of an unusual circuit. It's not how we would have implemented had we done a custom design.

But the potential advantage was, we could send that design to a foundry and they could build it.

And that was, I think, a clever recognition at the time and one that I certainly can't take credit for. We got it from other people.

Q. So the standard processes you're talking about as applied to the work that Dr. Fossum was doing was the CMOS manufacturing process, right, that was the standard process that he was able to leverage in a different way to further advance these CMOS photo detector arrays; right?

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A. Yes, I think broadly, that's right.

Q. And you agree that the CCD manufacturing process you talked about a little bit a few moments ago was more difficult and pretty tailored to the CCD issues?

MR. DAVIS: Objection to form.

A. So the "pretty tailored" I think is certainly true. You know, is it more difficult? It's a different production line, for sure, right? People made CCDs in the '70s and 80s and they worked very well, but the processes used were very tailored to do that.

So I'm not sure whether I really should call it more difficult or not, but it's certainly different and it's tailored.

So the difference between being able to buy shirts off the rack or having to have every shirt made by a tailor, right. Clearly, that's -- they're both doable, but one is probably more expensive than the other.

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Q. And a person skilled in the art wouldn't take that tailored CCD process to manufacture a device with a CMOS photo detector array, would they?

MR. DAVIS: Objection to form.

A. So the process optimized to do CCDs has steps which are very specific to the CCD pixel itself. You don't need those if you're using a CMOS pixel.

Now, could you do it? Well, yeah, you just skip those steps, but it would be silly to use that manufacturing facility. You'd be better off going to a standard CMOS manufacturing facility.

Q. It sounds like you would not mix and match CCD and CMOS manufacturing technologies in a single product?

MR. DAVIS: Objection to form.

A. Well, I actually -- we could probably find examples of CCD manufacturers who did that, but, again, it's because they already had those specialized steps available that allowed them to do this CCD.

So what I'm trying to point out

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is that if you have in hand the steps necessary to do the very specialized one surrounded by the more standard steps, you could do both.

But if you don't need the specialized device, then any fabrication facility that has the general ones can make it.

So it's the difference, again, between, you know, a tailored shirt still uses buttons manufactured by a big button manufacturer, right? The buttons were cheap and easy, you know, you don't use the custom -- the very narrow techniques if you don't need to use them. I think that's -- that's the point. That's one of the key differences between CCD and CMOS.

Q. You don't have to make the process harder than it needs to be if there's an easier way to make the CMOS photo detector arrays with a CMOS system that they can just use?

MR. DAVIS: Objection to form.

A. I think from the perspective of

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semiconductor manufacturing that you never want to use anything harder than you have to, and the more different products that can use the same process, the cheaper every one of those products would be.

So using a standard CMOS product to make an imaging device and making the digital controller in your dishwasher means they're both cheaper, okay, whereas using a highly customized process with a small market tends to cost you more per device.

Q. Dr. Fossum was describing in this exhibit, the focal point of the Exhibit, so 1060, that's the same Dr. Fossum whose work is cited and described and incorporated by reference in the '565 patent that's the subject of your declaration; right?

MR. DAVIS: Objection to form.

A. It is the same Fossum, yes.

Q. Also in this article there is a comment -- let me just go to that. Of course, now I can't find it. I was about to point you to it, but I'm sure once you

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answer the question, I'll find it.

Do you agree -- and I believe it's on the first page of the article, Dr. Fossum talks about the power required for a CCD imager compared to the power required for a CMOS imager, and he makes the point that a CCD image sensor with a CCD photo detector array requires more power than a CMOS image sensor with a CMOS photo detector array.

Do you agree with that?

MR. DAVIS: Objection to form.

A. I think that's -- that's a reasonable thing. I think the article says 100th to the power. I don't know whether it's 100.

But in general terms, yes, I think that's -- that is a characteristic of CMOS imagers compared to CCD imagers.

Q. And why is -- why do CCD image sensors with a CCD photo detector array require more power than a CMOS device with a CMOS photo detector array?

A. Well, in a CMOS pixel, as long

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as you could make good transistors with good off-state characteristics, low leakage, it means that once you store the charge there, it will stay there, and turning that transistor on and off is a relatively low power event.

For CCD, you do have to use -- you have charge stored in one element which you have to transfer to an adjacent element. And that stepping process requires more voltages and it's the movement of current in response to applied voltages, as opposed to in CMOS, you're allowing current to flow from a naturally occurring higher potential to a lower one.

So in CMOS, the part of the driving energy is already there.

In CCDs, you have to lift the -- you have to pick the bucket up to get it higher than the adjacent bucket and pour that out. That's a voltage and a current that consumes power, so that's sort of a very broad way to look at it in a very basic way.

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Q. Is it your understanding that most CCD photo detector arrays, the ordinary sensor with CCD photo detector array require a voltage of 12 to 15 volts for that device? Is that your understanding?

MR. DAVIS: Object to form.

A. You know, I don't honestly remember the exact voltage ranges.

That it is typically larger than what you use in, say, a TTL level CMOS circuit. That, I'm certainly aware of.

Q. So then based on that, a design of a CCD photo detector array image sensor would have different requirements than the design of a CMOS photo detector array image sensor, certainly with respect to the power levels that are required for the device; is that right?

MR. DAVIS: Objection to form.

A. They are different, and I think that although one of ordinary skill I think at this time, at the time of the patents, was well aware of both and well aware of

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their differences, but it is true, I think, that you would use different circuits to work with CCD than you would with CMOS.

Q. So would you agree then that CCD photo detector array components or -- strike that.

A CCD image sensor with a CCD photo detector array doesn't -- would not be interchangeable with parts of a CMOS image sensor, with a CMOS photo detector array, you couldn't mix and match the parts for those two image sensors; is that right?

MR. DAVIS: Objection to form.

A. So if what you're asking is if all of the electronics were present in great specificity, actually built, and you had a CCD chip plugged into that and you unplugged it and plugged in a CMOS chip and made no changes whatsoever in any of the other circuitry, that -- well, again, somebody could probably design the chip so that that would work, but I wouldn't expect that to be the normal course of affairs.

You would design the rest of

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your circuitry to be compatible with whichever type of imaging device you're going to use, focal point array you're going to use.

Q. Right. So that you would -- that approach, if somebody were to try it, would require a redesign of the device; is that right?

MR. DAVIS: Objection to form.

A. I think it is a different design and one that was well-known at the time, but it's a different design.

If by redesign you mean use a different one also known, just like the first one was known, I would agree.

Q. I just want to make sure we're not talking past each other, that if you had a CCD image sensor where the CCD photo detector array and a CMOS image sensor with a CMOS photo detector array and you wanted to take parts of one and use it in the other, that would require a redesign of whichever sensor you were trying to incorporate the parts into; is that right?

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MR. DAVIS: Objection to form.

A. I would expect that there would be parts of the electronics that you would replace. Again, with the design, I believe at this time, this was well-known to ones of ordinary skill, how to use a CCD as well as how to use CMOS, and there would be some differences at some point in the signal conditioning.

I would expect that the signal might be in a format that the rest would not have to change. But if you will, very close to the focal point array itself there are differences, for sure.

Q. So just on that point, you talked about the rest of the circuitry might not have to change.

What are you talking about and what falls into that "rest" category?

A. Well, it depends on what the overall functions of the camera are.

If the overall functions of the camera are to produce a standard video signal, the video -- for a standard TV, for

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instance, let's say NTSC format, that's well-known, it's a standard, and part of the electronics that do that formatting would -- I would expect would be the same for both.

At the opposite extreme, the information, as it first leaves the imaging pixel itself, it's different for the two.

And so, I mean, in both cases, it is charge, so it's current in both cases, so there are some similarities.

But, for instance, the voltages used to get that charge out are different, so there are drivers that I would expect to be different for the two. Some parts might very well be the same. Some portions of this overall camera system might well be the same. Some parts would definitely be different.

Q. I may have probably asked the harder question in terms of kind of what wouldn't have to change, but can you identify, again, in this circumstance, where you're combining devices, one is

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CCD-based *, the other is CMOS-based, * you're combining them, are there circuitry that would definitely have to change if you wanted to combine, let's say, putting a CMOS photo detector array into a CCD image sensor, which originally has a CMOS -- a CCD photo detector array?

MR. DAVIS: Objection to form.

A. I understand what you're asking.

It seems you're asking, the swap -- when you said one is CMOS, you're talking about the focal point array, one is CCD and one is CMOS.

Because I want to separate that from the rest of the electronics because it's highly likely that most of the rest of the electronics are CMOS anyway.

Q. Okay.

A. There may very well be analog circuitry in the rest. That's not CMOS. But -- well, it might be.

But if you're just talking about swapping the focal point array, the thing that has the pixel, then I would expect

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that certain parts of the readout electronics that gets the data -- the information off the chip, for CMOS and for CCD, they are different and you change those.

Now, again, at the time, in '95, the electronics necessary for CCD, that was well-known. There were CCD products out there and the CMOS designs I believe were also relatively well-known, so I think one of ordinary skill would know what to change, but they would have to change something.

Q. Any others? That sounds like you identified readout electronics, voltage drivers I believe you mentioned.

Anything else that would change in that scenario?

MR. DAVIS: Objection to form.

A. The readout electronics and the drivers, those are interrelated. I'm not really sure that I'd call them separate things. I just used different names.

The drive voltages are part of

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that readout electronics. They're necessary to read out the information.

So drivers, voltages applied, things like that, and I kind of call that broadly. I gave it a name: Readout electronics.

Q. Just so understand, the term "driver" or maybe "driving circuit," what is that referring to as you're using it there?

A. Well, so there are -- there are at least two sorts of the drivers in the kind of things we're talking about.

One -- the thing that produces the voltages necessary to make it operate, if they're not the same voltages as, say, the rest of the standard CMOS elsewhere, you need drivers to produce those different voltages.

If you need multiple levels of voltages, which for some CCDs it's a multi-faced system, those are drivers.

There's also the thing that makes sure that the signal is -- at least

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the chip is of sufficient magnitude for subsequent electronics to work with it, and those are frequently called drivers as well.

Q. And you talked about drivers to produce different voltage levels, that would be something that relates to a CCD device because I believe you said that the CMOS device just used the same voltage for the whole device; is that right?

A. Pretty much, the CMOS -- you know, there's some biassing for the storage regions, but I think generally what people try to do in their design is to try to make sure they use a design that uses the same logic level voltage as you use everywhere else. So in that sense, the whole -- an objective is to make sure that you don't have to have any custom voltages. That's why it has an advantage.

Q. That's why the CMOS implementation has an advantage, because it would all be the same voltage because it's all the same manufacturing technology?

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A. Right.

MR. DAVIS: Objection to form.

THE WITNESS: Sorry.

BY MR. CAPLAN:

Q. I'm sorry, I don't mean to talk over you.

That driver is something that's -- it is more directed to the CCD, where you could have these higher voltages and you said you can even have multiple different voltages in some CCD devices?

A. Yes, in some CCD devices, they're referred to as multi-phase. Phase identifying voltage levels.

Q. There are multi-phase CMOS devices, aren't there?

A. You know, I honestly don't know.

Again, I think a general objective in CMOS imagers is to avoid that.

That doesn't mean that somebody might not have discovered that you could get some other performance advantage by doing it, and then in their application maybe low light level with everything. I

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honestly don't recall.

It wouldn't surprise me, though, because people tend to be willing to do custom -- if you will, custom implementations if one performance metric is the most important for their application.

MR. CAPLAN: It's 1 o'clock. Can we take a short break here? Is that all right? Is 15 minutes okay?

THE WITNESS: If you don't mind, I know it's early for the West Coast, but if you don't mind I'd like to do a lunch break, so...

MR. CAPLAN: That's fine.

(Discussion held off the record.)

(A recess was taken.)

BY MR. CAPLAN:

Q. Before we took that last break we were talking about the driving circuits and I just want to make sure I understand that.

So we were talking about a CCD

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image sensor with a CCD photo detector array would need a driver circuit, certainly if it needs -- because it needs the higher voltages relative to a CMOS device, or it could also need multiple voltage levels; is that right?

MR. DAVIS: Object to the form.

A. I think in general, yes, that's typical.

Q. Now, for a CMOS image sensor with a CMOS photo detector array, it would not need a separate driving circuit because the whole device runs off the same voltages; is that correct?

MR. DAVIS: Objection to form.

A. I think I explained that there can be different types of drivers.

I mentioned drivers to produce voltages, but I also mentioned drivers that help move the signal to other places, to try to describe it.

So for the CMOS pixels, normally they're designed to not need any other voltages besides standard logic levels, and

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so those kind of voltage shift drivers would not be necessary.

The signals produced still have to be driven to other locations, so an example would be an amplifier is a driver. A line driver is an amplifier. So -- so it depends on -- you asked a question specific to the voltage levels.

That kind of -- we call that a voltage shift driver. That kind of driver would -- I would not expect to normally be present in a CMOS-type pixel, but might well be present in a CCD-type pixel.

Q. Now, if a CMOS photo detector array has -- if it's an active pixel, it has an amplifier at each pixel; right?

A. You know, I don't know that I've tried to determine a definition for active pixel.

Certainly I think that when there is an amplifier present, most people would put that in the class of active pixel. I'm not honestly sure whether there is some definition that's broader than

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that, but one with an amplifier at each pixel I think most people would agree is an active pixel.

Q. And are you calling that amplifier, if it exists in a CMOS photo detector array, an amplifier -- I mean a driver? I'm sorry.

A. So amplifiers drive signals, so they are drivers. So in a general sense, every one of those amplifiers is a driver.

There may well be other amplifiers in other locations to further drive the signal, for instance, off-chip.

But usually when you're talking about those, people just usually call it an amplifier, but the purpose of an amplifier is to drive a signal.

Q. Is there a distinction in the field -- and, again, in this late '90s time frame -- of a driving circuit?

Does that have a particular meaning as used with CCD image sensors and would it be used with a CMOS image sensor?

MR. DAVIS: Objection to form.

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A. I have not tried -- I've not tried to figure out some specific definition. Line drivers are well-known, voltage shifts -- I was using that term kind of broadly to get a whole class of things.

You know, it wouldn't surprise me if in some circumstances you'd find a block of circuitry that one person might label as a driver and another person might not label it at all. They might label it as an amplifier.

Q. Okay. But this sounds like we do agree then that a CMOS image sensor or the CMOS photo detector array uses the same voltage across the whole device; is that correct?

MR. DAVIS: Objection to form.

A. I think I said before that I'm not sure that everyone does, but I think that's common.

Q. In contrast, CCD image sensors with CCD photo detector arrays, because they require higher voltage for that bucket

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for gaining operation, do require additional driver circuits to make sure they have adequate voltage to operate the CCD photo detector array; is that right?

MR. DAVIS: Objection to form.

A. Again, to qualify a little bit, I think it is certainly typical, but could you go out and find some CCD design where someone made a compromise so that it can operate at a TTL -- old fashioned TTL plus or minus 5 volts? I suspect you could, but I don't think that would be a typical design. I think that would be a special purpose design.

Q. Okay. So I want to turn to your declaration a little bit and focus on things in there. I know you have a copy of that available.

So in your declaration, just for the record, it should be Exhibit 1004.

(Exhibit 1004 for identification, Declaration of Dean Neikirk, Ph.D., shown to witness.)

BY MR. CAPLAN:

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Q. You have Section 4, it starts on page 9. It talks about legal standards.

A. Yes.

Q. Okay. And if you need to take a look at anything before you answer, that's fine. Take your time. Just let me know you want to look at something.

Let's turn to or focus on paragraph 28 initially.

A. Paragraph 28?

Q. 28. It's on page 10.

A. It starts on page -- yes, I've got it.

Q. You've got it? Okay.

So I want to ask you the first sentence, which is the first five or six lines, but if you just take a look at that, in particular, I want to ask you about, you use a phrase "apparent reasons to combine known elements." That's the first.

It says you assessed whether there are apparent reasons to combine known elements.

Just if you can explain what's

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your understanding of that term.

A. Well, so the whole phrase:

"Assess whether there are apparent reasons to combine known elements in the prior art in the manner claimed in view of the interrelated teachings of the multiple prior art references."

My understanding is -- so first I'm looking at pieces of art that are already -- that I can establish are interrelated.

The elements in each of those, is there a reason to use some elements from one and other elements from the other.

So my understanding is you don't just arbitrarily pick and choose. In this situation, I'm -- one of the things to look for is, would one of ordinary skill have been motivated to make that combination, right, did they have a reason to do it.

Q. And what's your understanding or meaning that you use for that interrelated term? You said you would determine if references are interrelated.

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What does it take to be interrelated, in your view?

A. Well, I think, again, that's viewed of one as ordinary skill, seeing that the art, for instance, are in the same or similar fields, that -- maybe an easier one would be a counterexample.

Taking a cotter pin from a wagon wheel and putting it into a solid-state imaging device would seem likely to not be related teachings or interrelated.

But taking an amplifier from one imaging device and using it as an amplifier in another imaging device, well, they're both imaging devices. Well, that would be part of it. I want to read the context further, but generally.

Q. But if you were to combine two things, you would have to have a reason to combine them, wouldn't you?

A. Well, I think that is a consideration. If there is a -- if there are good reasons, then that's a compelling -- that's part of the argument.

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That not only do these elements exist in this combination, but one of ordinary skill would have a reason to have put them together that way.

Q. And in the same paragraph, 28, you talk about "effects of demands known to the design community."

Can you just explain what you mean by that aspect of your declaration? It's the next --

A. I'm trying to get it in the overall context of the paragraph.

So, again, I would look at whether in -- let's use this example. We're talking about building solid-state cameras.

So there would be a variety of demands known to the -- people working in that general area and so how those demands might be met by a particular combination would be something that's relevant.

You know, in other words, those in the area would -- again, it sort of -- have a reason to do it. There are certain

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demands that need to be met and this is a good way to do that.

Q. So you have to have a reason to make the combination. You wouldn't do it without a reason to go ahead and make the combination?

A. Well, I don't know whether the law would -- absolutely precludes the possibility, but certainly I think that it's -- that when -- when it's clear you have reasons to combine, that's an important issue, that having that is -- you have the motivation to do it. It's not arbitrary.

Q. If you turn -- actually, paragraph 28 goes on for a number of pages. You have a number of bullet points in that part of your declaration and you list a number of principles that you considered, and on page 12 there's one and it's "common sense."

Do you see that?

A. I do.

Q. So can you just explain how you

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apply that factor into your analysis in terms of, how do you apply common sense?

I'm not asking if you have common sense. I'm just saying, how do you apply it? What's the metric that you used to evaluate that?

A. So, you know, I think all of this is informed by one of ordinary skill in the art. I mean, it's -- one person's common sense might not be somebody else's.

But these are general -- general knowledge that one of ordinary skill would have by the definition of their skill level, right?

And that some item that has -- well, I called it a primary purpose. Common sense might tell you that a paper clip is usually used -- its common use is to hold two pieces of paper together. But, in fact, you can also use that to hold something else together. Two photographs together. I mean, that's pretty close.

But, you know, that common sense would guide you in this -- the function of

this, there's a typical function, but it's clear that it could be used in some other way, right? And common sense is the idea that -- that this wouldn't -- this should be something that would be easily seen by one of ordinary skill, I guess, maybe -- I hate to substitute words here, but that's how I think of it.

Q. So you wouldn't combine things if the result of the combination would actually make features worse because that would lack common sense.

Would you agree with that?

MR. DAVIS: Objection to form.

A. Not -- no, I don't think I'd agree with phrasing it that way.

I think you said if it made it worse, and the question now is made what worse. If it made one thing better but another thing worse, in balance, you might very well still do it, right?

I mean, so when you say making something worse, I want to know what got worse and I want to know what other

characteristics exist.

Did they all get worse, every single characteristic? Well, I would agree with you. That doesn't seem to be common sense.

But if five things got worse and three things got better, now I've got to try to think about, well, what was -- for your use, what was the most important?

Maybe those three things that got better was really all you cared about, so the things that got worse, you don't care about, so who cares. You do it anyway, right?

So I think that's part of the common sense, is -- is understanding that when you change something, things change, but you've got to look at each different category, you know.

We use noise in CCDs versus CMOS. It's pattern noise. Those are all very specific characteristics. And some people might not care about them at all. Other people might care about them

entirely. It depends.

Q. So I hear what you're saying. It's contextual. But if you have multiple factors that get worse with a combination and only a few that get better, then common sense may say it's just not worth doing?

MR. DAVIS: Objection to form.

A. You see, that's what I don't agree with. I think one of ordinary skill would understand using their common sense which figures of merit may matter than others, would matter than others, and they might very well recognize that the things that got worse, two of the three, I mean -- what did we say, three got better, five got worse?

They might recognize that three of the five don't matter at all, so now they're balancing three that got better and two that got worse, and they'd have to do a balancing act.

Q. Okay.

A. That's what designs in any electronic systems are about. It's always

a balancing act.

Q. On page 28 of your declaration, you have two paragraphs on claim construction, paragraphs 55 and 56.

A. Just for clarity, there's two page numbers, unfortunately. There's the exhibit page number and the original document page number.

I don't care which one you use. Just tell me which one you want --

Q. That's fair. In Exhibit 1004, it's page 31 of 177.

A. Okay. Yes.

So there's a -- yes. Elements or C claim construction. I do see that, yes.

Q. And your declaration says you're applying the plain and ordinary meaning to claim terms; is that right?

A. That's correct.

Q. And we covered this a little bit earlier, but I just want to go back and confirm.

In terms of -- and you would

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agree with me that the plain and ordinary meaning of the terms, if that's what you're going to apply, would be at the time of the invention, which for these patents is in 1997.
Would you agree with that?
MR. DAVIS: Objection to form.
A. Yes. So in -- yes. I mean, it's in view of one of ordinary skill in the art, understanding the terms at the time, yes. Terms could change meaning over time so it doesn't matter what it is today. It was then, yes.
Q. Okay. So my question is, how did you develop your understanding of a plain and ordinary meaning of the terms in the '565 patent in 1997, which is the filing date of the '565 patent?
A. Well, so I used -- first, of course, I read the entirety of the claim because context matters.
I consider the specification as well -- context matters -- to try to understand how the terms were used that

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would inform one of ordinary skill.
I look at the other art in the area, the interrelated art, to see how similar terms are being used.
And at the time, in the mid '90s, '97, I myself was working in the field and teaching students, and so many of these terms I believe are ones that were in pretty common usage and have a pretty clear basic meaning.
So I'm doing all of those things. I'm trying to view this through the lens of one of ordinary skill. Not necessarily my own skill level because I might be of more than ordinary skill, but we do have that definition.
The basic educational level, and just looking at the art, the contemporaneous art, the prior art is something being used pretty much the same way.
If it is, that helps inform, I think, what an ordinary meaning would be.
Q. In that time, in '97, at that

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time, you testified earlier that you were reading about CCD and CMOS image sensors, in particular, CCD and CMOS photo detector arrays as related reading to your core research, which was in a different area; is that right?
A. Well, so I think many of the terms in the claims relate to camera systems more broadly, or they might relate to printed circuit boards or other things, and those were in the core of my work. But also things that we just broadly discussed in our undergraduate EE curriculum.
So, you know, it depends on which words we're trying to understand. Some of these, the context is not specific to CCD or CMOS.
Q. Okay. Can you turn to Wakabayashi, the Wakabayashi patent, which is Exhibit 1027.
(Exhibit 1027 for identification, Wakabayashi patent, shown to witness.)
BY MR. CAPLAN:

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A. Okay. I have it.
Q. So to start generally, what is your understanding of what the Wakabayashi patent is describing?
A. Well, let's use the abstract.
It's talking about building a video camera. And I think that's a good characterization for, in general, what this is about, building a video camera.
And then it goes on to specify some of its characteristics. They'd like to make it compact, lighter in weight, they'd like to include a display unit as part of it, the video camera. They'd like it to be one where you can move the lens and point it different places.
So I have think the broadest, the simplest, it's about making a video camera and there are a number of characteristics that they'd like to incorporate into that video camera.
Q. Do you know if the Wakabayashi reflects an actual product that was actually sold?

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A. No, I do not know.

Q. So in Wakabayashi, it talks about -- and in your declaration it refers to -- you talk about Figure 7 of Wakabayashi. Let me just pull out your report.

And just looking at a little bit of your report, so looking at paragraphs 58 to 60 at the moment, but in talking about Figure 7, there is an imager device 27 and a circuit board 29.

Do you see those?

A. There, yes. Paragraph 60, yes. I see it. Yes, yeah.

Q. I want to get your understanding of what each of these components are doing, what their function is and what they're doing.

We can start with the imager device 27. What's your understanding of that component?

MR. DAVIS: Objection to form.

A. So the imager device 27 and let's -- I mean, I think later in paragraph

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60 I mention the solid-state imager device as being included in the camera head 100, and that I believe is a direct quotation -- yes, it is. It's a quotation from Wakabayashi.

And in my paragraph 60, I give you column 9, lines 10 through 14, where he discusses Figure 22. And he's talking about a block diagram, solid-state imager device, and let's see if he -- yes.

In column 6 he just calls 27 an imager device, but throughout Wakabayashi I think he always refers to the imager device when -- as a solid-state imager device.

So in the words that I used earlier when you were talking about my general background, this would be the chip that I was sometimes referring to as a focal point array. The thing that converts light into an electrical signal.

Q. Okay. And what's the role of circuit board 29 that's also shown? It's in your report and also shown in Figure 7.

A. So 29 itself -- let's find it in

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the discussion in Wakabayashi about 29...

MR. DAVIS: Same objection.

A. Certainly one of the things is the imager device is attached to circuit board 29.

In Wakabayashi itself -- let's see -- skipping forward a bit. Where is it -- actually, I'm going to flip through Wakabayashi directly. I'll see 29 faster there than I'll see it in my report.

Element 29 -- so in column 5 at lines -- is it 63 -- it talks about where it is as opposed to what it does. Sorry, I'm still scanning.

Q. That's all right.

A. Well, where is it.

He describes it as "camera circuit board."

Q. Do you have an understanding of that term as it was used in the field at that time?

A. I think in general terms it is generally a circuit board that would carry circuits used in the function of the

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camera. It's a camera circuit board.

You don't put in circuit boards with nothing on them. Then they're not circuit boards.

Q. What would normally be on a camera circuit board at the time of Wakabayashi?

A. I think it's a design choice.

MR. DAVIS: Objection to form.

A. You could put various things on various circuit boards. Some of the things might be on-chip. They might be on the board. You know, it depends on how you decide to partition the circuits that you need to make it function into different parts, into different circuit boards.

So I don't think there's a universal definition that says only these things are on a camera circuit board.

Q. Is there anything in Wakabayashi that you're relying on that tells you what's on that circuit board?

MR. DAVIS: Objection to form.

A. That's what I was scanning for,

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whether Wakabayashi has some further specific statements about functions performed on 29 or whether it's just you can put whatever functions there you want, and that's what I'm not seeing right now for 29. I'm not seeing anything further to Wakabayashi.

Q. Well, what's your understanding -- if there's nothing in Wakabayashi that tells you what circuit board 29 does, what's your basis for understanding what it actually does?

MR. DAVIS: Object to form.

A. I think it means that it's a design choice one of ordinary skill can make as to what they wish to put there.

Now, again, I'm trying to remember if we get into specific claim languages and what this circuit board reads on, I think it would be a more productive discussion as to what it needs to do and what my basis is for the arguments that it -- Wakabayashi does either disclose it or render it obvious.

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So this would be -- you know, when I did this, I was doing it within the context of the claims. Not in a universe without the claims involved.

Q. So you looked at the claims to figure out what you needed in the prior art to identify it for the claim; is that right?

MR. DAVIS: Object to the form.

A. No, I wouldn't characterize it that way.

Now, I do need to look at the claim for plain ordinary meanings and to understand, you know, I mean, there may be lots of disclosures in the prior art that are not claimed.

The question is, is the claim element disclosed in the -- and are all of the claim elements disclosed or rendered obvious.

Now, I'm not using -- was there a motivation to do it that way. I'm not using the claim as my roadmap for picking and choosing, but at the same time, if the

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prior art discloses other things, that's fine.

Q. In paragraph 61 of your declaration, that's on the same page 33 of Exhibit 1004, you talk about --

A. Excuse me, paragraph 61?

Q. 61, yes.

A. Yes.

Q. You were making reference to Figure 5 of Wakabayashi, and then you identify imager device 27, circuit board 29 and second circuit board 39.

Do you see that?

A. I do.

Q. Do you have an understanding of what second circuit board 39 does that you identified there? I know we just talked about imager device 27 and circuit board 29.

Do you have an understanding of second circuit board 39?

MR. DAVIS: Objection.

Form.

A. 39 -- so in column 6 of

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Wakabayashi at line 7 it specifically says that "the circuit board 39 includes a signal processing" --

(Reporter clarification.)

A. So at column 6 starting at line 7, Wakabayashi specifically says:

"A circuit board 39 disposed in housing 3, circuit board 39 includes a signal processing circuit for the video camera unit 5, a driver circuit for the liquid crystal display 38, a system circuit, power supply circuit and so on."

So for that one he actually says some of the things specifically on 39. Of course he says "and so on," so there could be lots of other things there as well.

Q. So what does the "signal processing" mean in the context there that you just identified for this device?

A. Well, for this device, there are a number of things. There is -- and I'd have to check to see if he puts it somewhere else, but there's a conversion from -- to a video format, because he wants

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to -- he says that he wants to produce a video format compatible with a video display. That will require certain kinds of processing. That's an example.

Q. When you say "conversion to a video format," is that for display on a TV or other display device? Is that what you're talking about?

A. Well, in Wakabayashi, I think he says -- let's see -- I do believe he says something about that. That's why I'm looking for it.

I don't know that this is the best example, but in column 8 he references signal supported by a VTR, videotape recorder, and that one of ordinary skill in the art would understand at the time that videotape recorders recorded in standard video formats.

It seems like there's another spot too.

Q. Where would that signal be coming from?

A. Well, ultimately he says that

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circuit board 39 has signal processing and including that, for instance, a driver circuit for the liquid crystal display, so I think that the disclosure would suggest that ultimately it's --

(Reporter clarification.)

A. -- coming from circuit board 39. I believe that's what I said.

Q. Just so I'm clear, I was asking where that image, where that signal is coming from that's being processed by board 39, that's what --

A. I'm sorry. I misunderstood your question. I thought you were asking about the VTR -- the signal going to the videotape recorder.

Q. That's where the signal is going, I assume.

A. Right. So the way it's described, circuit board 29 is coupled to 39. Originally, the light is converted to an electrical signal by the solid-state imaging device, which is -- sorry -- looking at Wakabayashi's numbers, which is

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30 -- I'm sorry, 27, excuse me, in Figure 7 it's 27.

So where is it coming from.

Well, originally it's coming from 27.

27 passes into 29. 29 is then coupled via the little ribbon cable to 39.

Q. And the signal processing you're saying is done on board 39, though?

MR. DAVIS: Object to form.

A. Well, what Wakabayashi says is that signal processing is done there "and so on." He calls out -- what does he call out: Driver circuits, signal processing.

He does say a signal processing circuit. He doesn't say that's necessarily the only, but he says a signal processing circuit is there.

Q. So let's start at the imager device 27 and just kind of to walk through, because you've identified a pathway, but I just want to go from start to finish just so the record is clear.

So the imager device 27, that is

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the original generator of an image signal; is that correct?

A. Well, that is where light is converted -- that is where light is converted into an electrical signal, so in that sense I would say that's the origin of the electrical image.

Q. And you agree, because I think it's in your declaration, you say that Wakabayashi does not identify the particular type of focal array that's in Wakabayashi; is that right?

A. I think --

MR. DAVIS: Object the to form.

A. I believe Wakabayashi is silent. I don't think he cares. It needs to be solid state. That's all he asks for.

Q. And so there is an image signal. Would you call that a pre-video signal that comes out of image device 27?

MR. DAVIS: Object to form.

A. Pre-video is a claim term.

I think one of ordinary skill in the art as plain ordinary meaning would

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interpret that to mean something other than standard video format. It's pre-video.

And, yes, I believe that signals emerging from a typical solid-state imaging device are not yet formatted in video format, so that would be a pre-video signal, yes.

Q. So there's a pre-video signal coming out of imager device 27, which Wakabayashi does not tell you a particular type of imager device that that is; is that correct?

MR. DAVIS: Object to the form.

A. I think that that is correct, yes.

Q. Okay. And that image signal, which we're going to call a pre-video signal, is going to camera circuit board 29; is that correct?

A. Yes. Signals pass from the solid-state imaging device 27 onto and into circuit board 29, yes.

Q. And is it an analog or a digital signal going from imager device 27 to

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camera circuit board 29?

A. So --

MR. DAVIS: Object to the form.

A. In Wakabayashi, because he's silent as to what kind of solid-state device it is, it -- I don't think it says.

Now, in terms of these details, in my analysis I went to other analogous art to try to learn about the details of a solid-state imaging device. In particular, I used Ackland, and Ackland is certainly analog.

MR. CAPLAN: Dr. Neikirk, I will not let you accuse me of not keeping my word, and it's 2 o'clock. 2:01. So we'll break. An hour, is that fine?

THE WITNESS: An hour is plenty.

MR. CAPLAN: Or 45 minutes even. I have to end around 6:30 East Coast time, so that's 3:30 your time.

(Discussion held off the record.)

(A luncheon recess was taken from 2:01 p.m. EST to 2:46 p.m. EST)

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

(Time Resumed: 2:46 p.m. EST)

DEAN NEIKIRK, PH.D.,

having been previously duly sworn, resumed and testified as follows:

CONTINUED EXAMINATION

BY MR. CAPLAN:

Q. So before we broke for lunch, we've been going, marching through the Figure 7, so I'm just going to pick it up there.

And I believe we were talking about imager device 27, the outputs, but we -- I think we agreed to call the pre-video signal to the camera circuit board 29.

Do you agree with that, Dr. Neikirk?

A. Well, I don't know whether I agreed -- I pointed out that in my analysis of the claims for the imager chip 27, I referred to Ackland and the signal produced by Ackland, which is an analog signal.

It is certainly pre-video in that example, the one that I used, and that

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is provided to board 29.

Q. Okay. And it was your testimony that Wakabayashi itself does not describe the particular type of imager device 27 that is described and that's shown in Figure 7; is that right?

A. Wakabayashi calls it a solid-state imaging sensor or imaging device. We identified that a few minutes ago. And other than that, he didn't say which type. That is correct.

Q. And does solid-state imager have a meaning to you in the context as it's used here in Wakabayashi?

A. It certainly does.

Q. What is that?

A. It's not, for instance, a videocon (ph.), which is an electron-to-imaging device. It's not a piece of film.

It's made up of solid-state device, which would include, for example, CCDs or CMOS image, focal plane arrays.

Q. So at this point, you're

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interpreting Ackland -- I'm sorry -- you're interpreting the Wakabayashi imager 27, in view of Ackland, to put a pre-video signal out to camera circuit board 29; right?

A. So the combination with Ackland, yes, that would be correct.

Q. Well, right now I'm just asking about your understanding of Wakabayashi. Not Wakabayashi with Ackland. We're going to get to that.

But I'm just asking you your understanding of Wakabayashi is -- it sounds like you can only understand it in combination with Ackland.

Is that your --

A. No, no. That's not what I'm testifying.

MR. DAVIS: Object to form.

A. You asked and you added some words to all of this.

For instance, you said that 27 produced a pre-video signal.

Well, Wakabayashi I don't believe uses that terminology at all, and

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so I can't say that Wakabayashi shows what kind of output. We use 27, it passes to 29.

Wakabayashi says it's a solid-state imaging device -- I'm sorry, I keep losing track of what -- what phrase exactly he used -- "imager device."

He does call it a solid-state imager device, but other than that, he doesn't provide any further detail.

Q. And you don't have any independent understanding of what particular kind of imager device that would be, absent looking to Ackland; is that right?

A. Well, the solid state --

MR. DAVIS: Object to form.

A. That it is solid state. He says that but he doesn't further limit it.

Q. Okay. And then we went through this before, but I'll go through the whole sequence now, from imager device 27 to board 39, what happens at camera circuit board 29 in your understanding and in

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combination with Ackland?

A. Well, in --

MR. DAVIS: Object to form.

A. In combination with Ackland, we know that Ackland contains timing and control circuitry as part of 27, and that is on circuit board 29.

The claim language requires it to be thereon a first circuit board, I believe, is the claim language, and that is met by that combination.

Q. Okay. I think we're mixing metaphors a little bit in terms of your invalidity analysis and just what you understand from Wakabayashi, but is -- there are connections shown between imager device 27 and board 29 in Figure 7.

Do you see that?

A. Yes, I do.

Q. And is that the basis that you say imager device 27 is on the circuit board?

A. Yes. It's certainly on that circuit board 29. I can't think of any

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other way to describe it.

Q. Okay. Now, you mentioned timing and control circuitry in connection with the imager device; right?

A. I did.

Q. And I believe you said that the timing and control circuitry is part of the CMOS device in Ackland; is that right?

A. We can check Ackland, but that's my recollection, yes.

So if you look at Figure -- Figure 6 of Ackland, yes, I believe that's what's indicated. That is a possibility. Ackland clearly discloses timing and control switches.

Q. Right. And you testified previously, you said in combination with Ackland, we know that Ackland contains timing and control circuitry as part of 27.

Do you agree with that?

A. I think that what Ackland would teach one of ordinary skill in the art is that that timing and -- the timing controller element 20 of Ackland could be

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part of Ackland's chip; and, hence, part of 27. And because of that, the timing controller of Ackland would be on circuit board 29.

Q. Is the timing and control circuitry also on imager device 27?

A. I believe that is what Ackland would teach one of ordinary skill, yes. That's one possibility.

Q. I'm just asking what your position is. So timing and control circuitry on imager device 27 and on circuit board 29?

A. So I believe -- yes, that it is by -- if it is on the imaging solid-state device 27 that's taught by Ackland, then it is on circuit board 29.

Q. And that is because the imager device 27 is physically connected to circuit board 29.

Is that your position?

A. Well, it's -- it's physically connected and it is clearly on it. It is mounted directly to it. It is soldered to

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it. It is a direct connection. It is sitting on circuit board 29. There's no question if you look at Figure 7 of Wakabayashi.

Q. The timing and control circuitry, is it your understanding that that's now/NOT part of imager device 27, is integrated on the same piece of silicon that -- I'm assuming it's silicon -- that is imager device 27.

Is that your testimony?

MR. DAVIS: Objection to form.

A. So I believe that in my analysis I identified that as one of the things one of ordinary skill in the art would, looking at Figure 6, understand, Figure 6.

Q. Okay. And that imager device that you're taking from Ackland with the timing and control is connected to circuit board 29 as shown in Figure 7 of Wakabayashi; right?

A. It is mounted on circuit board 29. It's electrically connected and mounted on.

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Q. Now, what other circuits are actually kind of on the same plane as circuit board or a part of circuit board 29?

MR. DAVIS: Objection.

Form.

A. So I don't believe Wakabayashi specifies any particular other circuitry as being on 29. And in my analysis I was looking at claim language and I don't believe there was a discussion of requiring other circuitry -- one of the claims, at least -- be on the first circuit board, or "thereon," I believe is the term.

Q. My question is, do you know what other -- do you know what other circuitry is on board 29?

MR. DAVIS: Objection.

A. I believe that what other circuitry would be put on circuit board 29 would be up to the designer.

Q. Okay. And what happens to the image signal that we were talking about, which I believed you characterized as a

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pre-video signal coming out of the imager device 27 that goes to board 29? What happens at that point?

MR. DAVIS: Objection to form.

A. Well, in my analysis, there wasn't any -- it wasn't in the claim language, any -- looking for other things that happened on that first circuit board.

I think Wakabayashi leaves it up to the designer as to what -- how they partition things between the circuit boards. Wakabayashi doesn't specifically say, I don't think, that you have to do one function on 29. He does give information about functions on 39, but that leaves it up to the designer.

Q. Does Wakabayashi somewhere say it's up to the designer to put particular functions wherever you deem it appropriate? Is that part of Wakabayashi?

A. I think Wakabayashi being read by one of ordinary skill in the art sees a printed circuit board. Printed circuit boards are used to contain circuitry.

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And Wakabayashi doesn't tell you that you have to put -- which specific circuitry to put on 29, so it's an option. It's something that is an option to one of ordinary skill as to what they decide to put there.

Q. Is there something express in Wakabayashi that says it's an option to put whatever kind of circuitry the designer wants on board 29? Can you identify that?

A. I don't think that there's an express statement said that way.

It identifies that 29 in Wakabayashi is a circuit board. He calls it the camera circuit board.

Now, I'm trying to remember -- if you give me just a moment to look at Wakabayashi.

Q. Sure.

A. There's a discussion -- I'll look at both Wakabayashi and my declaration. Mine is section -- there's an overview of Wakabayashi that starts on page 32 of the exhibit numbers.

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Q. Okay.

A. So, for instance, to my paragraph 60, but let's go to column 9, Wakabayashi. At column 9, line 10.

So he does identify a block circuit diagram, that's Figure 22 of Wakabayashi, and he identifies that the camera head 100, which includes wide receiving lens, solid-state imager device, a circuit for driving the solid-state imager device and so on, generates an optoelectrically converted signal 101 which is input to camera circuit 102.

Camera circuit 102 includes camera signal processing circuit, synchronized signal generator and so on, generates video signal 103.

So he does a circuit diagram 22, the camera head, which is 100, and camera circuit are illustrated there.

Q. You're talking about Figure 22 now; is that correct, Doctor?

A. Yes, there's camera head 100 and camera circuit 102.

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He explains some of the things that that does and ultimately generates a video signal at 103 in Figure 22.

So Wakabayashi has two circuit boards, 29 and 39. The camera head -- I'm sorry, I'm flipping around a bit more -- which in Figure 22, the circuit diagram, he calls it 100, right? Yes, he does.

He says what's in camera head 100, lens, solid-state imager and circuit for driving solid-state imager and so on.

So at the least, that would be in the other figure we were talking about, Figure 7, 27 and 29 are inside Wakabayashi's element 5, which I believe he uses the phrase "video camera unit."

Q. Right. Were you done?

A. Figure 22 in the description in column 9, at the least, I believe that the camera head would include the elements it describes of which circuit board 29 is part.

Q. Okay.

A. He does give you some

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explanations as to what circuitry is present, certainly.

Q. You mentioned a couple of times you were reading from column 9.

There's a circuit for driving the solid-state imager device, is in the list of what's included in camera head 100.

Do you see that?

A. I do.

Q. What is that circuit for driving the solid-state imager device that's described there?

A. There are many such circuits. It depends on what kind of solid-state imager it is.

We talked about drivers earlier. There are many different kinds.

Wakabayashi hasn't specified which type of solid-state imager device and has provided no further specific information about a given circuit. There are many such circuits.

Q. We spoke earlier, and we were talking about, as you pointed out, the CCD

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devices versus the CMOS devices and how -- and you testified that the CMOS devices used one level of power in their device compared to higher level regarding the CCD devices.
Do you recall that?
A. I do.
Q. Okay. So -- and I believe you testified that the CMOS devices with the CMOS pixel array would not require a driving circuit because they're operating at the same CMOS voltage as the rest of the device compared to the higher voltages required by the CCD devices?
MR. DAVIS: Object to form.
A. That was not my testimony.
My testimony was that it wouldn't have the voltage drivers.
If you recall, my testimony was that there are a variety of different kinds of drivers and that voltage drivers to shift levels was a specific type.
Wakabayashi doesn't say -- doesn't limit it to that kind of driver.

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He simply says that -- "circuit for driving."
Well, there are lots of such circuitries. And for a CCD, one of the things you might need is a voltage shift driver, and I did testify that for CMOS you wouldn't necessarily need that. But I never said that there are no drivers.
Q. In the context to a person of skill in the art in Wakabayashi, is there a meaning for this circuit for driving the solid-state imager based on your understanding?
A. Precisely what it says. Given a particular choice for solid-state imaging device, one of ordinary skill would be able to identify an appropriate driver circuit.
Q. So it's your testimony that whatever a person decides Wakabayashi can mean, you would have a driving circuit appropriate for whatever you decided it could mean; is that right?
A. One of ordinary skill in the art selecting a given solid-state imager

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device, which Wakabayashi leaves that as an option, that's why he doesn't say what kind. One of ordinary skill in the art would understand what kind of driver circuits would be appropriate for that imager.
Q. You would agree with me that when we're talking about Figure 7, that board 29 should be characterized as off-chip with respect to imager device 27.
Do you agree with that?
A. I think that that would be a common understanding.
I don't believe on-chip is -- it's not claim language and it's nothing that I've particularly tried to understand, but I think that would be a common view. What is not on the chip is off the chip.
Q. So picking up -- I think picking up where we were, so now we have a signal coming from the image sensor, or the imager device 27 that goes to board 29, and I don't think you've testified as to exactly what happens to the signal at board 29,

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have you?
MR. DAVIS: Objection.
Form.
A. No, I don't think that's quite correct. I was quoting from paragraph 9, which identified camera head. Let me look -- so there's camera circuit 102.
Camera circuit 102 identifies signal processing circuit.
If you look earlier in column 6, it says that the signal processing circuit for the video camera unit 5 is on circuit board 39.
So reading these together in Figure 22, some of the circuitry is on 29. Some is on 39.
And part of what's required in the block labeled 102, camera circuit -- according to Wakabayashi, column 9 -- is signal processing.
He did tell me where that is. He said that's on 39.
In column 9, Wakabayashi tells me the camera head 100 includes the wide

receiving lens, solid-state imager device and a circuit for driving solid-state imager device and so on.

That's what it says.

If you look at Figure 3, you see where the lens is, you see where the circuit board 29 is, you see where the solid-state imager device 30 is. They're all inside 5.

And although he didn't say that camera head 100 is only what's inside 5, the description he gives is consistent with that.

Several of the elements that -- in circuit diagram in Figure 22 called camera head 100 are clearly inside 5 in Figure 3.

So the circuit board 29 is certainly involved in that functionality, 100, in the circuit diagram for Figure 22, just as he specifically says that the signal processing -- a signal, camera signal process circuit is in that second block 102, but he earlier says that's on

39. So he is giving indications as to how various things are partitioned between 29 and 30.

Q. And, Dr. Neikirk, you can't tell me now, it sounds like, what functions are performed on board 29 and what functions are performed on board 39, can you?

A. I believe --

MR. DAVIS: Object to form.

A. I believe that in column 9 he's telling you that at least on 29, which is where the imager device is attached, that there's a circuit for driving the solid-state imager and so on.

Now, he doesn't say whether that's necessarily on-chip or off-chip, but this is all part of camera head 100.

So I believe that one of ordinary skill in the art reading that would interpret that to mean that's related to circuit board 29.

He's very clear that functionality contained in camera circuit 102 is on circuit board 39.

Q. What is the process being done on 39 then?

A. Well, he tells you what the process being done on 102 -- in 102, which includes camera signal processing circuit, synchronization signal generator and so on generates video signal 103.

He earlier clearly stated that on circuit board 39 is that it includes a signal process circuit for video camera unit 5, a driver circuit for the liquid crystal panel 38, a system circuit, a power circuit and so on.

Q. So is it your testimony then that camera circuit 102, which is shown in Figure 22, is on board 39 then? Is that your testimony?

MR. DAVIS: Objection to form.

A. Certainly parts of 102 are on 39. He's very clear about the signal processing circuit.

It doesn't make sense I think to one of ordinary skill in the art to place the rest of what he describes as being in

102 onto 29.

If the signal processing circuit is on 39, then you'd put the rest of that on 39. There are only two circuit boards identified in Wakabayashi. It's all got to be on one or the other.

Q. So all the signal processing is either going to be on board 29 or 39 is your testimony; is that correct?

MR. DAVIS: Objection to form.

A. No. Did you just ask me if I was testifying that the video -- that the signal processing was on 29? I'm sorry, maybe I misheard your question.

Q. You said it would make sense if you put all the signal processing in one place, so I believe you're saying it would be on board 29.

Is that your testimony?

A. No, no. That's not what I testified.

I said that in column 6 he specifically says that the signal processing circuit is on 39. It's at

column 6, line 7 through 10, very explicitly.

So that element of camera circuit 102 at least is certainly on 39. He says so. It's an explicit disclosure.

Q. And that signal processing circuit for the video camera unit; right? That's what it says.

MR. DAVIS: Object to the form.

A. So in column 6 it says that circuit board 39 includes a signal processing circuit for the video camera unit 5. That was what it says.

Q. And what kind of processing is that doing?

A. Well, he identified a number of things. He identifies generating a video signal 103 in television signal format from the optoelectrically converted signal 101. That's in column 8 -- let's see -- at line 16. Now, that is identified as a generation -- it actually doesn't say that's specifically part of the signal processing circuit.

He does have other disclosure related to turning upside down images right side up. I'm trying to look -- let's see. Does he identify that as signal processing or is he more generic about signal processing. Let's see.

Oh, no, actually, he identifies that it's circuit 107. That's the version.

But if you look at Figure 22, there are numerous other circuit blocks.

For instance, power supply circuit 115. Well, he's already said in column 6 that the power supply circuit is on 39.

Q. It's your testimony -- is it your testimony that camera circuit 102 is also on board 39?

MR. DAVIS: Objection to form.

A. He explicitly has stated that the camera circuit 102 includes camera signal processing circuit.

In column 6, he explicitly states that signal processing circuit for the camera unit is on 39.

Q. So your testimony is yes, that circuit 102 is on board 39; correct?

MR. DAVIS: Objection to form.

A. So certainly at least part of 102 is on 39.

Q. What part would be on it?

A. Well, the part that he explicitly discloses, the signal processing circuit.

Now, looking at the other things that he mentions as being part of 102, including synchronization, signal generator, signal path and so on, which produces -- generates -- excuse me -- video signal 103, so it leaves -- the camera circuit 102 is a video signal in television format.

And given the things that you would need to do to all this, to go from the optoelectrically converted signal 101 to video signal 103 in television format, I believe one of ordinary skill in the art would interpret that, yes, the things that are described as being in 102 would -- some

of it is required to be on -- is an explicit disclosure that it's on 39.

But the rest of it only makes sense if it's on 39, so I would say that what Wakabayashi is teaching is the fact that it's located on 39.

Q. And board 39 is also off-chip with respect to imager device 27; correct?

A. Yes, it's not part of the chip, 27.

Q. And you did make reference to what you were referring to earlier, I think it was in column 6, a driver circuit for the liquid crystal panel 38, column 6 between lines 5 and 10.

Do you see that?

A. I do. At that point it says that circuit board 39 includes signal processing for video camera, driver circuit for a liquid crystal panel 38, a systems circuit, a power supply circuit and so on.

Q. Is that the same driver circuit that we spoke about in connection with Figure 22 in column 9, where you were

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testifying earlier?

MR. DAVIS: Objection to form.

A. No, no. In column 9 it says that the driver for the solid-state imager device. In column 6 it's a driver circuit for the liquid crystal panel.

Those are not the same in any way, shape or form.

Q. Okay. Now, in Figure 22 you pointed to element 104, which I believe is a flipping circuit.

Is that what you -- I think you pointed that out recently.

Do you recall that?

A. Yeah, I don't think it's necessarily the entirety of 104. Perhaps it's -- it explains -- sorry.

Q. What's your understanding of that circuit in Wakabayashi that's identified by 104?

A. So in column 9 at line 22, it states that the video signal 103 is next input to an image arrangement converter circuit 104, and then he goes on to explain

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how pieces within 104 function in order to take an upside down image, and based on further down in column 9, starting at line 46, when the video signal 103 represents an upside down image, this image should be converted to an upright image, as described above, whether an upside down image has been taken, in a sense, based on a rotating angle of the video camera unit 5.

He then goes on and explains that -- let's see -- then when you have detected such an upside down version image -- I'm down around line 58 -- the read address circuit 107, which is -- that's in the bottom of the box dash line 104 -- forced to generate addresses in the reverse -- in the order reversed to that of the right address generator 106, whereby a video signal 111 is read from RAM 105 in order reverse to the order in which the video signal was written.

Explains quite clearly what it does there.

Q. Do you know why Wakabayashi

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needs that particular circuit in it?

A. Well, because Wakabayashi has a rotating -- I keep trying to use his phrasing -- camera unit 5 does rotate.

Q. It has a selfie mode in it?

A. I don't recall whether he calls it a selfie mode, and it doesn't necessarily -- I don't know whether he restricts it to only point in two directions. It certainly rotates.

Q. Do you have an understanding of how pixel arrays or I guess the photo detector arrays are read out for a CCD photo detector array?

A. I think I've already actually described that. A typical CCD array reads out the entire pixel content in a serial fashion.

Q. And for a CMOS photo detector array, is it the same mechanism to read out the pixel array?

A. Well, firstly, the physics is not the same at all because in a CMOS array, switches are used to connect pixels

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via row and column, address thing.

But in a typical CMOS array, you read out one column after another and then the image data again is serial, but it's collected, if you will, a column at a time. So one column follows another column follows another column.

Whereas in a CCD, at least the most common version, it's not the only way to do it, but the most common, it's one pixel followed by another pixel followed by another.

And depending on how the CCD was built, that might be in row order, it might be in column order. It's not in random order.

Q. A CMOS photo detector array, though, is addressable in the XY.

You can read it out randomly, each pixel; is that correct?

A. Some can be. It doesn't necessarily -- a lot of them use a common, for instance, a column address, so you read out the whole column or you don't read it

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at all.

Q. Would a CMOS photo detector array need a circuit like that 104 in Wakabayashi to --

A. Circuit -- absolutely.

Q. Why is that?

A. Because at that point it's in television video format. That was -- that was done by camera circuit 102.

Once it's in television video format, it has no idea whether it came from CMOS or CCD. That's managed. That is irrelevant.

Q. We're still going to talk about Wakabayashi, but I do want to bring up the Ackland reference, which is Exhibit 1006.

A. Okay, I have that in front of me.

(Exhibit 1006 for identification, Ackland patent, shown to witness.)

BY MR. CAPLAN:

Q. Okay. So you mentioned this a few times.

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You looked to Ackland to get an example of an imager, an imager device that you used to replace imager device 27 in Wakabayashi; right?

A. Well, I think I wouldn't agree with the word "replace."

Wakabayashi says it needs to be a solid-state imager device and gives no further detail. Ackland is a solid-state imager device.

I'm not really sure how you call that a replacement. It provides further detail of however a specific type works, yes.

Q. So what's your understanding of the Ackland patent, Exhibit 1006?

MR. DAVIS: Object to the form.

A. Well, it's -- as its title says, about CMOS active -- about a CMOS active pixel image sensor, although it is addressing a specific way of building the pixels in terms of fabrication technique that only requires one level of polysilicon.

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So in general terms, it's about a CMOS active pixel imager. And in more specific terms, one -- Ackland is talking about the way of making the fabrication use, in some sense, fewer steps by using only one level of polysilicon.

Q. You testified earlier that Wakabayashi doesn't specify the particular type of technology that could perform the function of the image sensor 27 for the imager device 27; right?

A. Well, he says it has to be solid state. That eliminates many things.

Q. Okay. But it wouldn't eliminate solid state -- well, what's your understanding of the options for solid-state imagers that could be used with that?

A. Well, the CMOS smart pixel is an example. CCD is an example. Photo diode arrays are made of solid-state devices, and photo diode arrays could be made without -- without using CMOS technology, for instance. So those are three examples that

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come to mind. Let me think.

My own microbolometer work, those were devices made that are solid state as well. They were not semiconductors, but that's still solid state. It's not, you know...

Q. What was the problem or deficiency in Wakabayashi that would cause -- that caused you to combine another reference, Ackland, with it?

MR. DAVIS: Objection to form.

A. Well, so in order to -- if someone reading Wakabayashi wanted to build Wakabayashi, they're going to have to pick a sensor, and I believe that at the time one of the choices certainly would be CMOS.

This is -- these are in the same art. They're about cameras.

And so Ackland teaches the details of a solid-state imaging device.

Q. But the solid-state imager is just one part or one component of Wakabayashi; is that right?

A. I would agree it is.

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Q. Wakabayashi has a number of other components in it; correct?

A. Yes, I believe Wakabayashi is replete with details about mechanical arrangements and the image and version circuitry, in particular, for the video, the rotatable camera head.

So, yes, there is certainly other components.

Q. But it has -- I'm sorry?

A. Excuse me. But without the solid-state imaging device, of course, there's no camera.

Q. Wakabayashi also has at least two off-chip circuit boards, 29 and 39, that we were talking about before, in addition to those other items?

A. Absolutely. In particular, he shows two circuit boards, yes.

Q. And we talked earlier about the development of CMOS technology and we talked about Exhibit -- I think it's 1060, the Business Week article involving Dr. Fossum.

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Do you recall that?

A. I do.

Q. And one of the things we talked about was the state of the art with the CMOS imager photo detector technology, which was taking advantage of making it out of CMOS.

Do you recall that?

A. I do.

Q. And that was one of the benefits you explained; correct?

A. Yes, because by making it CMOS, it meant that you could leverage existing fabrication facilities.

Q. And you would get -- it would all be integrated in one device.

That was the whole point, the camera-on-a-chip; right?

MR. DAVIS: Objection to form.

A. No. No, no, no. You don't integrate the power supply in that.

In fact, the amount that you integrated on that array depended on a person's design.

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The earlier ones integrated nothing else, and then people, because it was CMOS, they had the option to integrate other things. But I know of no chip -- well, I think this is fair.

I don't know of any chip that has 100 percent of everything you need to build a camera on that chip.

Q. Is that your understanding of "camera-on-a-chip" as used in the Business Week article about Dr. Fossum's work when it says "get ready for the camera-on-a-chip," that's 100 percent of everything on one chip?

A. No, that's not my understanding.

MR. DAVIS: Object to the form.

A. They did not mean that everything was on one chip.

They meant -- first of all, they meant the ability to have other things on there, but by "camera-on-a-chip," I don't think anyone ever intended that to mean that your entire camera is now that single chip.

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Q. But a number of components could be put on-chip if you took the CMOS approach; is that correct?

A. Yes. Some components, some circuitry could be placed on that chip.

Q. And I think you explained earlier, you testified earlier that it would be smaller and less expensive; correct?

A. So I think what I was testifying to was that by adding in that circuitry you can take -- again, you're leveraging fabrication. You don't manufacture two pieces of silicon. You make one.

So the net effect is that it is likely to be -- if you added the two dye area and you forced them to be in the same space, it might be a bit smaller.

Now, if you can remove the other function to another circuit board, I mean, you know, smaller is relative to what you're trying to build. I think what I was talking about was, as much as anything, is the fact that you're using a standard CMOS

process makes it easier to integrate standard CMOS -- other CMOS circuitry. I believe I also pointed out that there were -- and I believe there may still be -- CCDs that do have some peripheral circuitry on the same chip, but that's a specialized process because the CCD process was specialized.

Q. You just mentioned standard CMOS processes being integrated in the CMOS device.

That would include signal processing, wouldn't it?

A. No. I'm sorry. In that context, by processing, I meant the -- the fabrication process. Not the circuit. So signal processing is an electrical phenomena. The fabrication process is the steps of photo lithography ion implant, oxidation diffusion lithography. All of those steps. When I was talking about processing, standard processing, that's

what I was talking about. IC fabrication processing. I'm sorry if that wasn't clear.

Q. And with CMOS image sensors with CMOS photo detector arrays, you could use standard CMOS manufacturing to incorporate more features on-chip in the manufacturing process; is that correct?

A. Yes.

MR. DAVIS: Object to form.

A. Yes. I think that is correct. You could. You'd have that as an option you could select.

Q. And putting -- when we started developing the CMOS image centers with CMOS photo detector arrays that were integrated this way and took advantage of the CMOS manufacturing ability, all the components being made with a similar manufacturing method, that was also referred to as having a lot of the features on-chip, right, as referred to in the article with Dr. Fossum?

MR. DAVIS: Object to form.

A. Yes. When you use a single

piece of silicon to fabricate many different -- different circuitry, then all of that circuitry is on-chip. That would be the phrasing.

Q. And we were just talking about Wakabayashi, and you agreed that Wakabayashi describes a device with off-chip circuitry, right, circuit boards 29 and 39 are off-chip; right?

A. He certainly does. But, again, as I think I've mentioned, I don't think I've ever -- someone may have built a CMOS imager that contained, for instance, a microprocessor. That might exist, but I don't think most of them do. So what Wakabayashi was doing was partitioning different pieces in different places and he said where to put Wakabayashi's camera -- let's try to use his wording: "Signal processing circuit for video camera." He did say where to put that and it is off-chip, but I don't think that that's too surprising.

MR. CAPLAN: You want to take a short break here?

(A recess was taken.)

BY MR. CAPLAN:

Q. Dr. Neikirk, a couple of things to kind of pick up where we were talking, discussing the circuit 104 in Wakabayashi, which deals with the inverted or the flipped image.

And you testified that if -- that would not be necessary -- it would be necessary in a CMOS device if the image was already in TV format.

Do you recall that?

MR. DAVIS: Objection to form.

A. No. What I said was that Wakabayashi's output 103 is in video format. He specifically says it is. And once it's in video format, the rest of the system doesn't know what kind of sensor it came from, whether it's CCD, CMOS, it couldn't care less. It does not know once it's in video format. It could have come from an old-fashioned video

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com tube.

So, yes, if you want to flip the image over once it's in video format, you need to do what's in 104. I know that there may be other ways, but you can do what's in 104 in Wakabayashi.

Q. If you could access the image before -- the image data, the pixel data before it was converted to the television format, then you would need that circuit to convert it, though; right?

MR. DAVIS: Objection to form.

(Reporter clarification.)

A. If you would repeat the question.

Q. Sure. That would be easier.

If you could access the image data and the pixel data before it was converted to television format, then you wouldn't need a circuit to convert it to a different orientation; correct?

MR. DAVIS: Objection to form.

A. No. If you had access to the data prior to conversion to video and you

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wanted to, quote, "convert it," unquote, you'd have to have some other circuit. Otherwise, it's not inverted.

Q. But if you could read out the array, the pixel array, in the right order to account for whatever the orientation is, you wouldn't need another circuit; is that right?

A. Well, but then you'd have --

MR. DAVIS: Object to form.

A. You would have to have a circuit that allowed you to read it out in a different order. That's a different circuit for CCD or CMOS or other solid-state imagers.

There is typically by the architecture of the imaging chip itself, there's an order format, and if you want to change that order, it will require circuitry to do that.

Q. You would agree that a CMOS active pixel photo detector array is addressable, is XY addressable; right?

A. Not all of them. Some of them

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are column addressable, so some of them will automatically give you all the data in the column or a row.

Some of them do allow you to get to one pixel at a time. It varies, it depends.

Q. But that's a feature of CMOS photo detector pixel arrays; right?

A. Well, it is a feature --

MR. DAVIS: Object to form.

A. It is a feature that is certainly much easier to implement for CMOS than it would for, for instance, CCD.

I -- I can't honestly say whether somebody hasn't just done an exotic CCD design that allowed them to get to smaller pieces of it.

I -- I don't know. It's certainly easier, I think, for CMOS than it is for CCD.

Q. So you agree then that that circuit 104 that's shown in Wakabayashi is necessary for a CCD photo detector array; right?

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MR. DAVIS: Objection to form.

A. It would be necessary for either -- I mean, by either.

It would be necessary for CCD as it would be necessary for CMOS.

Q. You have testified it may not be necessary for CMOS because the CMOS pixel array is, in fact, addressable.

It doesn't come out in that bucket brigade; right?

MR. DAVIS: Objection to form.

A. That's not what I testified.

You asked if it was addressable. I agreed.

What I testified was that if you wanted to alter the order in which you read out the pixels so that you read them out in one order for one circumstance and a different order for another circumstance, that would require circuitry.

The -- it's not the same as 104 because 104 is operating on a video signal, but in some sort of -- so the means would be different but the result would be -- but

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you would still have to have a circuit to do it.

MR. DAVIS: Dr. Neikirk, if you could just pause a little bit more before the answers. We're talking over each other and I want to make it easier for the court reporter. Thank you.

THE WITNESS: My apologies. That is a habit of mine. I'm sorry.

BY MR. CAPLAN:

Q. What circuit would you need to change the order of the readout in a CMOS you were in?

A. Well, if it was a CMOS circuit that dumped data in a serial fashion row by row, you'd at least have to have an address circuit that reversed the order in which you activated -- I said rows. Usually it's columns. It doesn't really matter. Let me use columns.

If you did it in columns left to right, for normal circumstances, if you wanted to so-call invert that, you would have to read right to left, and that,

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actually, you would have to do more.

You'd have to say that the column on the furthest right is going to be converted to data for the video display that's on the furthest left.

So it's not just simply the order in which you read it out. It's the further conversion to saying "this order should be different in the video display."

If I read a CMOS array out left to right or right to left, it's the same image. I have to fool the video system into believing I read it left to right when I actually read it right to left. That requires circuitry.

Q. Have you ever designed a circuit to do that function?

A. To do an inversion function like that? No, I've never done that because none of my imagers were one where we needed to invert the image.

Q. So you've never worked on this feature with a CCD photo detector array or a CMOS photo detector array, have you?

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MR. DAVIS: Objection to form.

A. No, but this is -- excuse me -- no, I have not because I haven't had call to.

But this is simple basic understanding of how data in a two-dimensional array is ultimately displayed on a display. There has to be a mapping between a specific location in the original array and a location in the display.

And in order to invert, you have to change that mapping. Anybody who takes pixelated data and tries to display this would know that.

Q. You do agree then that the way a CCD photo detector array is read out is different than the way a CMOS photo detector array is read out; right?

MR. DAVIS: Objection to form.

A. I think, generally speaking, yes. I believe they are read out in different manners.

But in Wakabayashi, since he

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does the inversion after conversion to video, it actually didn't matter for the inversion process.

Q. Let's talk about Wakabayashi a little bit more then.

So one thing that we've been talking a lot about is the imager device 27 in Wakabayashi, right, and we talked about Figure 7 and the imager device 27. We talked about that a lot.

A. Yes, we certainly discussed that.

Q. And it's in your declaration.

You testified today that your understanding is essentially this is a roadmap to do whatever you'd like to do as a design matter, and you looked to Ackland to get that feature; is that correct?

MR. DAVIS: Objection to form.

A. I'm not exactly sure that's how I phrased it.

What I said was is that Wakabayashi doesn't pick a type of solid-state imaging device 27. So one of

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ordinary skill wishing to build something like this would be motivated to seek out further information on a particular type.
And I pointed to Ackland as providing that kind of information.
Q. Now, instead of Ackland, why wouldn't you or why didn't you pick a CCD image sensor to add more details about imager device 27 in Wakabayashi?
A. Well, I think as the patent -- sorry -- we're supposedly doing the '565 today.
It's as the '565 admitted in its introduction, CMOS was widely known and it was known, as we've discussed, to have advantages, certain kinds of advantages.
Given that Wakabayashi appears to be something aimed at a consumer camera market as opposed to, say, scientific instrument, I think one of ordinary skill at the time would have already been aware that for a lower cost option, CMOS has advantages, so they would have a preference, I think, to look for CMOS image

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chips as opposed to CCD.
Q. So you did look at the '565 patent to figure out what was the best element to put in Wakabayashi for that imager device 27?
MR. DAVIS: Objection to form.
A. No, I don't think that's the correct way to phrase it.
I just explained to you why I believe that one of ordinary skill in the art who would have all of the literature at their -- available to them, they would know it all, what the motivation would be for that person looking at Wakabayashi in a consumer sort of camera, why they would lean -- why they would look to a less expensive solid-state imager, which I believe it was widely recognized and acknowledged that CMOS was such an image -- solid-state image sensor compared to a CCD.
Q. So let's talk for a minute about the consumer camera market.
So in 1995 to '97, the relevant time frame that we're talking about, what

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was your understanding of the consumer camera market at that time?
A. Well, I believe that the consumer -- you know, I've forgotten exactly the years. Mid to late '90s is really the best to pin it down in my memory.
Q. That's fine.
A. There were cameras introduced. There were even cellphone cameras introduced, if I remember right.
Some of the earliest I think did use CCD, but they were rather expensive, and, again, I think one of ordinary skill taking advantage of the literature that was available, including Ackland, knew at the time that they could reduce cost by going with the CMOS option.
So I think there's a clear -- that is one -- clear motivation to go that direction.
We talked about other advantages from the perspective of circuitry. Not requiring multiple voltages. Well, I think

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one of ordinary skill would recognize that as an advantage as well.
Q. Is there something in Wakabayashi that talks about making design choices with the description that is provided in the Wakabayashi patent that focuses on lowering cost when you make those design choices?
A. Let's see.
You know, I think Wakabayashi, in its introduction, focuses a lot on being able to do the image reversal.
He certainly talks about making the camera units small so he can pivot more easily.
I don't know whether Wakabayashi itself explicitly uses the word "cost," but, again, I think this is something that would be well-known to one of ordinary skill.
I mean, this is clearly not a scientific instrument, Wakabayashi. He's talking about something -- let's see, in the introduction, a video camera. I think

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he talks about it's got a PCMCIA slot, so it's designed to connect to another computer.
You know, the simplest way I can put it is this is not a scientific instrument. Scientific instruments emphasize performance over all other focus.
Consumer products don't do that. Performance is certainly relevant, but cost is highly relevant as well, and I think that one of ordinary skill would recognize that if you could reduce the cost, that would probably be a good thing to do.
Q. Wakabayashi, if you look at the front page of Wakabayashi, you're aware that that patent is assigned to Hitachi Limited of Tokyo, Japan?
A. I'd have to look again, yes. It's certainly assigned to Hitachi.
Q. Did you ever look at Hitachi's products from that time period? This application was filed in August of '95.
Did you ever look at Hitachi's

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products, their consumer camera products, to see what they had in the market at that time?
A. I can't say that I recall that I did or did not.
I've certainly looked at -- not necessarily in the context of this case, but, you know, there's the Camera Hall of Fame, where you can see cameras of different types from this time period, and I honestly don't remember.
I remember several of the companies were Japanese, but that's all I recall.
Q. So you don't know if Hitachi at that time was making cameras that were primarily featuring CCD photo detector arrays, do you?
A. No, I don't know.
Q. With your declaration, that's not anything that you looked at, is it?
A. I'm sorry --
Q. In connection with your declaration, that's not something that you

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looked at in preparing your declaration?
A. No. Wakabayashi is clearly silent on the type of sensor and I've just explained why I think one of ordinary skill would be motivated to look at CMOS sensors.
Q. Right. And you identified cost a couple of times as a factor.
Is that the primary factor?
A. Well, I think for consumer products --
MR. DAVIS: Objection to form.
A. For consumer products, that certainly is one, and perhaps a fairly important one.
Wakabayashi discusses size in a variety of contexts. You know, the size issue depends on pixel size a lot, and pixel count.
At the time, and I believe you'll see this at least in Fossum's laser focus tubing article, there was a discussion of pixel size, and at this time the standard line width in CMOS was quite small. It was, I believe, about a micron.

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I don't really recall what the CCD processors were doing, but I think they tended to have bigger pixels in this time frame, so size would come into it as well.
Q. I know I used quality before and it wasn't the right term. I think you preferred signal-to-noise ratio, but do you know the state of the CCD imager art, signal-to-noise ratio, in this August of '95 time frame?
A. Do I know the number and in nanovolts per --
Q. No, no --
A. No, I don't recall the number.
Q. No. Just in general, kind of where the state of the CCD photo detector array art was at that time in terms of signal or noise, and at least relative to CMOS at that time.
MR. DAVIS: Objection to form.
A. In that time frame, I do believe that the noise 4 in CCDs was lower than in CMOS. I believe the fixed-pattern noise in CMOS was worse, but that's different from

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saying that they were bad enough in CMOS that they were unusable.

And, in fact, that is what was going on in that time frame. The demonstrations that people were doing for CMOS was to show that the noise 4 was low enough to make high quality images.

Q. Would you agree, though, that putting CCD photo detector array in the Wakabayashi patent design would give you a better image output from the device through the CCD?

A. I wouldn't phrase it that way.

MR. DAVIS: Objection to form.

THE WITNESS: Sorry.

A. I wouldn't phrase it that way.

In normal lighting conditions, I don't know that that would be the case at all.

Noise 4 is typically a much bigger issue under low light conditions.

And, again, given the way this -- Wakabayashi is described, it doesn't sound to me like this was probably a design

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for use on a telescope, where the light levels were exceedingly low.

So, no, I'm not sure at all that in this application that a CCD would have provided superior image quality to a CMOS.

Q. Is that your opinion or you know? Is it just your opinion or do you know that, in fact, CCD arrays were no better than CMOS at that time?

A. What I know -- you said "better." "Better" is context sensitive.

What I know is that the noise 4 for CCDs was lower than CMOS.

What I also know is that noise 4 is an issue under low light circumstances.

What I don't know is, for instance, did the person trying to build this want to operate at midnight on a moonless night. Seems unlikely.

Given the description of connecting to a monitor and using it for things that appear to be videoconferencing kind of applications -- I'm not sure that Wakabayashi says "videoconferencing," but

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the context suggests that -- in which case it would be the lighting more like in an office.

And I don't know with absolute certainty that a CMOS would be as good as a CCD, but I'm -- I didn't do that as an investigation for my report.

But I would be very surprised if CMOS was worse than CCD in that context, of a typical office lighting situation. And, excuse me, I said "worse." In terms of the impact of noise 4.

Q. Just so I understand noise 4, what is that referring to, noise 4?

A. So if you use a camera, a solid-state imaging system with a solid-state imaging chip in it, and you do it in the dark, there will still be an image. It will be made up of noise.

And the apparent brightness of that noisy signal in the image you view is what I'm talking about. How -- when it should be completely dark, then you would hope your screen would be absolutely black.

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Well, if you look hard enough, that's never true.

For an astronomer, they have a star, which is a point object, adjacent to what they hope is very dark sky, and they'd like to look at a very dim star, which means they really want the sky adjacent to it to really be black. So that noise 4 is very important to an astronomer.

In your office, I can see your image right now. I see mostly fairly light-colored objects, with the exception of something that looks like kind of a dark wood paneling behind you along the ceiling and along one side.

Well, in that image, I don't think noise 4 is showing up at all.

Nothing there is dark enough for me to ever notice the noise produced by the image.

Q. Going back to '97-'98, that time frame, do you know if -- and let's talk about consumer cameras because we were talking about that in the context of

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Wakabayashi and you were testifying earlier, so at that time, the dominant imaging technology in consumer cameras in '97, was it CCD or CMOS?

A. I -- I don't know as I sit here right now what it was in '97.

I seem to recall -- again, I mentioned the Digital Camera Hall of Fame, it's a website, and being an amateur photographer I have looked at that stuff before.

And I believe I've seen both, but I can't say that I've looked at it to try to determine what the dominant was.

Q. What was the cost difference between CCD and CMOS photo detector arrays let's say in '97? That's the date the application was filed, the filing date.

A. Again, I don't know a precise cost difference.

I do recall building a camera system for use with our chemical sensors, which we discussed earlier today. And to do that I bought a CMOS imaging chip. Not

a CCD. And part of the reason I bought that, as I recall, the chip itself only cost me maybe $10 or less.

It worked -- it was very easy to use. So that's the one I picked.

Now, I can't honestly recall whether I looked at CCDs, partially because having known about CCDs from 15, 20 years earlier and my recollection was that they were harder to use and more expensive, but I couldn't quantify it beyond that.

Q. So when you purchased this CMOS imager, when was that? I know I had asked about '97, but --

A. You know, I can't honestly recall whether it was '97 or whether it was 2000. It was somewhere in that time frame. I don't remember exactly.

Q. Okay. And earlier we talked about Dr. Fossum's article, Exhibit 1060, and the evolution of CMOS, the image sensors, the camera-on-a-chip, in leveraging CMOS manufacturing, and then in that article and in our discussions, you've

talked about the different kind of structure for the CCD devices, which have a lot of off-chip circuitry.

Do you recall that?

A. I don't know that that was -- the difference has a lot to do with how you have to fabricate it. So whether you put the circuitry on-chip or off, you've still got the problem of fabricating the individual photo detectors.

And that's the -- that's a lot of what makes CCD fabrication different from CMOS. And it's not -- I mean, I believe I said this, that by going to all CMOS for both the image conversion element, the pixel, by going to CMOS, it makes it much easier to incorporate other CMOS circuitry because it's all fabrication compatible.

But there are steps in the fabrication of a CCD device which are not -- I wouldn't say that they're completely incompatible with CMOS, that's not true, but they are sufficiently different that

the fabrication facility is not a standard CMOS fabrication facility. It's more specialized.

I believe that's what I explained before.

Q. Okay. And what Wakabayashi shows in imager device 27 and off-chip circuit boards, which we talked about before, so if you're going to -- my question is, why combine a CMOS array from Ackland in that structure of Wakabayashi, which has these off-chip circuit boards, with respect -- relative to the imager device?

A. Because the cost advantage of CMOS imagers is not entirely due to adding circuitry to the chip.

The fabrication facilities used to make the pixels themselves, those fabrication facilities by this point in time were very standardized. I believe you'll probably find reference to people like Fossum having their arrays built using MOSIS.

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MOSIS was a foundry service, and you could get anything built by MOSIS as long as it was a specific kind of CMOS.

The facilities were -- the costs were amortized over many, many, many application fields.

People who wanted to build CCDs had to have a dedicated line to do that.

I believe the very article that you referenced, there is a statement in there about a cost to entry was high. The Japanese had already paid the cost. They were already making CCDs.

But the CMOS opportunity to the domestic silicon fabrication companies was that they wouldn't have to make that new investment. Even if they incorporate no extra circuitry on-chip, they still garner that advantage.

Q. And what Wakabayashi describes, as you said, was a consumer camera device, it was already designed, it existed.

And so -- do you agree with that?

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MR. DAVIS: Objection to form.

A. It was already designed and existed? No, I don't know that.

Q. Well, the patent existed and it shows a particular design with components.

Do you agree with that?

A. Right, the patent does.

I don't know that it was a consumer product that I could have purchased. I just don't know.

Q. And you're picking -- and you've already testified and you agree that the Wakabayashi design incorporates off-chip circuitry; right?

A. Yes, it does.

Q. And you just testified that if you have a CMOS array, that leads to more CMOS circuitry because you get a benefit in manufacturing to leverage out what you can, implement it in CMOS; right?

MR. DAVIS: Objection to form.

A. No, that's not what I testified.

What I said -- excuse me, I talked over the objection again.

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So what I said was that whether you had that circuitry or not, you garner the same advantage of using standard integrated circuit techniques.

Ones that were widely used for circuits that had nothing to do with optical devices, that had to do with 555 timers or a microprocessor that runs a dishwasher. It had to do with -- it was general purpose, and you garner that benefit whether you had circuitry to the chip itself or not.

Some of the circuitry that Wakabayashi discusses requiring -- including, for instance, the conversion to video, is not something that is -- at least at the time of this -- was trivially done in silicon.

So that -- one of ordinary skill was going to need some circuit boards to do some of the circuitry, they would have expected, whether they used CCD or CMOS.

I've explained that I believe that one of ordinary skill would have

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looked to CMOS, recognizing that that chip, that component, whether it contained a lot of off -- on-chip circuitry or not, would have an advantage over CCD in terms of cost.

CCD was unlikely to have much circuitry on it at all. Even if you got a CMOS active pixel array, for instance, with no circuitry on the chip, it would have cost less.

Q. So you testified earlier that based on your review of Wakabayashi, you can't tell if imager device 27 is a particular type of solid-state imager; right?

A. Wakabayashi only says it's a solid-state imager, and I don't believe there's anything else in Wakabayashi that would tell me that it is one type or another.

Q. If it was an imager, image device 27, and Wakabayashi was a CCD image sensor, then in that case trying to put Ackland into the Wakabayashi design would

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be quite difficult; right?

MR. DAVIS: Objection.

Form.

A. Well, in that case, it wouldn't make any sense. You wouldn't put Ackland. If you were required to use a CCD, then one -- one of ordinary skill would never look to Ackland.

Ackland is not CCD.

Q. Okay. But you're assuming for the purposes of your explanation, at least as I can understand it, is that Wakabayashi is not a CCD device?

A. No. I said that Wakabayashi shows no -- he doesn't show any preference. He's silent on this issue.

You asked a question that said, "gee, if it was CCD, putting in Ackland would be very expensive," and my answer was that if it was CCD, you'd never put Ackland in because it's already done. You picked a CCD.

Q. But --

A. Wakabayashi doesn't pick CCD or

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CMOS.

Q. Wakabayashi does pick off-chip circuitry with respect to the image sensor; right?

A. Certainly, it does, which would be required for both CCD and CMOS.

MR. DAVIS: Dr. Neikirk, if we could just pause.

THE WITNESS: I'm sorry.

MR. DAVIS: I'm stating my objection to form again.

Thank you.

BY MR. CAPLAN:

Q. Would putting the Ackland CMOS photo detector array into the Wakabayashi design get you a better image quality or a better signal of noise in the image? Do you know?

MR. DAVIS: Objection.

Form.

A. As -- I mean, that question -- I don't -- better compared to what? Better requires a reference.

Q. Well, I'm trying to understand

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why it would be beneficial to do it.

Why are you picking -- my question is why are you picking a particular -- why Ackland?

A. Well, I gave you a reason:

That one of ordinary skill would have at least been aware that CMOS imaging chips were less expensive than CCDs and required different circuitry, but as we discussed earlier, they don't require multiple voltage levels.

Q. When you put -- if you were to put the Ackland photo detector array into the Wakabayashi design, what other elements of Wakabayashi would you keep? Do you know?

MR. DAVIS: Object to the form.

A. Let's look at Figure 22.

So at the level at which he describes -- and they're functional descriptions, not schematic circuit diagrams -- I think I would keep probably everything in Figure 22.

Q. Is there anything you know that

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you would have to change in Wakabayashi besides the photo detector array from Ackland?

MR. DAVIS: Objection.

Form.

A. Well, at the level of detail that Ackland describes, I think the answer is no.

Again, it's -- I believe that one of ordinary skill in the art is motivated to combine these two references because in order to implement actual -- Ackland gives functional descriptions largely and rather broad descriptors.

For instance, we repeatedly discussed the signal processing circuit for the video camera. That's all Ackland gives.

To build this, I believe one of ordinary skill in the art would seek other information to actually implement, Ackland being a good example of details on the solid-state imaging device.

MR. CAPLAN: If it's okay, I'd

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like to take a short break here.

(A recess was taken.)

BY MR. CAPLAN:

Q. So, Dr. Neikirk, picking up where we were in the combination of Wakabayashi and Ackland, so we've been talking a lot about cost.

And so if cost is an important factor, as you've testified, why have a device with multiple boards, as shown in Wakabayashi, if you could implement it with more on-chip integration, as would be done with CMOS at the time?

MR. DAVIS: Objection to form.

A. Because sometimes, depending on the functionality, it does cost you more to put it on-chip, and I'll use as an example the conversion to standard video output, which is a -- video output is purely analog, has a lot of information encoded and a lot of different frequencies.

And that process is not really compatible with the purely digital CMOS product. It requires what's called a mixed

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signal integrated circuit to do.

At this time frame, mixed signal ICs were fairly exotic, pretty expensive to design and fairly expensive to build.

So that's an example of why sometimes putting it on-chip is not a good thing to do. Sometimes it is. Sometimes it's not.

A number of the things that Wakabayashi wants to do, that being one, he actually calls out -- again, here referred to as, column 6, a signal processing circuit for the video camera.

Depending on what kind of signal processing you wanted to do, if you wanted to do that, you might need an A-to-D converter, you might want a DSP chip followed by another D-to-A.

Those things, again, were in many cases available for use in many applications. They were general purpose pieces of silicon.

And it's -- they were cheap because everybody bought them to do a lot

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of things. A lot of people bought them to do a lot of things.

Trying to integrate that into your dedicated imaging chip, somebody else might not want those functions and then they have to pay for them.

So partitioning function between chips and boards and other chips, which are usually on other boards, or on boards, is a common everyday activity for somebody building stuff.

So I don't think it's at all obvious that you'd be best to put everything on the solid-state imager and have no circuit boards at all from a cost perspective. I don't think that's clear at all.

Q. So you made reference in this answer to "mixed signal ICs."

What is that referring to?

A. So a mixed signal IC is one that requires manipulating both digital and analog. It also -- one of the problems you have with video, pure analog video, is in

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many cases even if it's all analog being in the end, no digital anywhere, some of the filtering implementations you need require components that are not -- well, a band-pass filter, for instance, using capacitors and inductors, especially at this time we're talking about, on-chip inductors were not available. So you had to go off-chip onto the board to even implement the video filters, usually with a wire wound inductor and other components.

So mixed signal was one that came to mind as a general descriptor, but staying entirely in the analog domain, it's the same issue.

That there are certain analog functions that really are not easily implemented on-chip.

Q. But if you were going to implement a CMOS photo detector array, wouldn't you try and implement as many other features as part of that same component, since it would all be manufactured with the CMOS technology?

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MR. DAVIS: Object to form.

A. Not necessarily. Not necessarily. It would invariably increase dye area. Cost per chip tends to track dye area. The more you add, the bigger the dye, and at that very basic level, it will cost more.

But if you're putting functionality on there that some people need and other people do not, the people who don't want it don't want to pay for it.

If you keep it to being the imager only, everybody who's doing imagers needs the imaging chip, so it becomes a general purpose device.

The peripheral circuitry is probably going to vary from one application to another, and so you want the user to be able to place that where they need it, what they need, and not what they do not need.

And it is the idea that integrating everything including the kitchen sink onto a single dye is always a good idea is certainly not true.

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Q. You wouldn't have to integrate everything for the device; right? It could just be subcomponents; right?

A. You might integrate some, in which case you'll need circuit boards to do the others. It will be off-chip.

Q. So when we were talking about the camera-on-a-chip technology that's described in the patent, but also in the Business Week articles, Exhibit 1060, you'd agree that the camera-on-a-chip didn't mean that in that device that had the camera-on-a-chip there wasn't other circuitry separate from the camera-on-a-chip; right?

MR. DAVIS: Objection to form.

A. I think that the vision was that for some applications you might include certain other things.

But it would vary by application as to what you would want to put on there. And the general idea was that by going to the CMOS standard process, standard fabrication process, you enable the ability

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to put other standard -- other CMOS circuitry on board.

It doesn't mean that you would always want to do it, but it's enabled, and I think that was really the whole pitch, if you will, for the so-called camera-on-a-chip.

You could incorporate what you felt you needed. In a modern camera -- a camera of the time, it might well have been more economical to do some of these functions off-chip.

If a manufacturer made -- if Ackland's manufacturer made just the pixel array, then anybody could use it without paying anything extra for the chip.

Now, granted, they'd have to put it off-chip. But, again, I think this is a common design trade-off that one of ordinary skill would be aware of and would be willing to practice.

Q. You testified earlier today that the ability to leverage the CMOS manufacturing process for CMOS photo

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detector arrays generated a lot of cost savings at that point, when you were able to leverage that manufacturing process; right?

MR. DAVIS: Object to form.

A. Yes, I did say that, and that applies even if you're only building the pixels themselves, because you're using a fabrication line whose costs have been spread across many, many other products.

Q. Right. So it was your testimony, though, that you would take advantage of that when possible because it would be more cost effective; right?

MR. DAVIS: Object to form.

A. Yes, I believe I testified that that was true even if no other circuitry was on there because the simple manufacturing process of the pixels themselves is cheaper than the dedicated line.

If you look at that -- that article you raised this morning, they talked about cost of entry.

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Cost of entry was the specialized fabrication processes necessary to make the pixels in CCD, which does not exist if you use CMOS pixels, regardless of whether you add additional circuitry.

Q. But in that article -- you should feel free to take it out if you have any questions -- but it expressly talks about one chip incorporating all sorts of electronic controls, usually they're multiple chips.

That was the trend in the industry; right? That was your testimony earlier today.

MR. DAVIS: Objection.

A. I don't think I testified that that was the trend in industry.

That in some cases that was a general philosophy, but it was always well-known that at some point you carry that too far, and I gave you a good example: Analog filters.

Nobody was putting analog filters on-chip in this era because they

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just didn't work.

It was cheaper to use discrete components on a printed circuit board.

Q. You agree that Dr. Fossum's technology was to put CMOS technology, as much as he could, on a chip, to have a camera-on-a-chip. That was the point of his technology; right?

A. I think I phrased it slightly differently.

Not as much as you could, but as much as you should. There's a big difference.

As much as you could says you ignore all other design issues and all other fabrication issues.

As much as you should is an engineering balance. And for consumer products, it's a mixture of typically size for the application and cost.

Q. But if cost is a concern in your design of a product now, taking advantage of the CMOS camera-on-a-chip if you're going to use a CMOS photo detector array is

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something that a person would consider.

That's common sense; right?

A. They'd consider it and they may then conclude that it was cheaper to implement it elsewhere.

Q. You testified earlier today that, especially in light of the article we looked at, Dr. Fossum and his work in the CMOS image sensors, that the on-chip integration was a feature of the CMOS image sensor technology; right?

MR. DAVIS: Objection to form.

A. I don't know that that was the question and that was the way I phrased the answer.

Again, by using standard CMOS fabrication, you certainly enable that. That doesn't mean that it was impossible to integrate other circuitry with CCD, for instance, and this -- I don't know whether this article mentions that, but it is certainly discussed in the literature.

But you lose the standard process because as soon as you go to CCD,

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you have to use a specialized one for the pixels.

Q. And that CCD manufacturing process, one of the features of it was you would wind up with a device which had a lot of off-chip circuitry; right?

A. Well, what it resulted in was a manufacturing process that cost more, and --

Q. And -- I'm sorry?

A. And so that in and of itself drove you to not waste a dye area or spend additional money to mix two processes.

So if you want to put standard CMOS on the same chip as the CCD, you actually have to mix two fabrication processes and that doesn't give you economy of scale anymore.

So one of the choices there is, you've already spent the money for the CCD pixel. Don't waste anything more.

The other components are easily obtained as standard CMOS products. Put them on boards.

Fabricating printed circuit boards is not necessarily an expensive proposition, and most electronic systems, no matter what the level of integration, still contain more than one chip integrated together in some fashion using either a printed circuit board or a flexible board or something, and that's done because it's cheaper to do it that way.

Q. So it's your testimony that you wouldn't mix standard CMOS technology on the same chip as CCD because you'd be mixing fabrication processes and that doesn't give you economy of scale; right?

That's your testimony?

MR. DAVIS: Objection to form.

A. I don't believe I said you could not or that it never happened.

In fact, I believe I said there are examples where it did.

What I did say was that as a general rule, a trade-off, it is not at all clear that that will be advantageous, or there might be some limited level of

circuitry inclusion that is and then a level of circuitry inclusion that is clearly not.

Q. Are you familiar with tests to evaluate the signal-to-noise ratio of CCD or CMOS image sensors?

A. Tests for doing photo detector signal-to-noise? Certainly, because I've done many of those.

Q. Are you familiar with something called SNR-10?

A. SNR-10 I assume is referring to a specific standard, so I don't know that particular standard, but I'm certainly familiar with signal-to-noise ratio measurements, and, again, having done many of them myself.

Q. Are you familiar with a Delta E star test for image sensors, CCD or CMOS image sensors?

A. Delta E star stands for the -- well, there's a noise equivalent temperature difference. That is the energy difference reference to noise.

Basically it has to do with the smallest amount of photon energy which you can detect.

There are -- there's ways of measuring what's called noise equivalent power, NEP; there's ways of measuring what's called Delta T -- what is the acronym for that one. It's the noise equivalent Delta T.

So there's a lot of different ones. D star itself is specific detectivity, if I recall, and that is a measure of sensitivity, which is different from noise.

When you try to evaluate signal-to-noise ratio, you have to know both sensitivity and noise, and it's essentially like a ratio of the two.

Q. Are you familiar -- do you know Dr. Ackland? You were talking about the Ackland patent.

Do you know Dr. Ackland and know of him?

A. No, I do not.

Q. You testified before that your combination of Wakabayashi with Ackland was not to solve any particular problem in Wakabayashi, was it?

MR. DAVIS: Objection to form.

A. I don't think I said it that way or even said that at all.

I think that Ackland has left the type of photo detector -- what is it -- 27 -- open, and in order to implement, one of ordinary skill in the art is going to need to make a choice. And I think that is a strong motivation to keep reading the literature.

Now, clearly Ackland and Wakabayashi are in the same field of art. They would have -- my understanding is one of ordinary skill in the art knows all of the related art, so they would be aware of these, as well as be motivated, for instance, by consumer goods, which Wakabayashi is an example of, to think about cost at the very least.

The size issues are certainly

part of it, but I think that one of ordinary skill, in order to build this would want details about the imager and, as we've discussed extensively, would gravitate towards CMOS, given the era, as I think the patents themselves admit.

And furthermore, the single poly CMOS version from Ackland, his patent was based around the idea that he could do it with a single poly rather than double poly, and that basically makes it cheaper.

I don't know that Ackland phrased it that way, but anybody who does fabrication is aware of that.

Q. So it's your testimony that the Wakabayashi patent is related to a consumer camera product; right?

MR. DAVIS: Objection to form.

A. I think that the description in terms of the video unit and pointing at a user and pointing away and displaying on a TV monitor suggests it is not a scientific instrument.

Sounds like the description of a

handheld video unit either for taking movies, presumably he talks about putting this to a videotape recorder, or for videoconferencing, although I don't think he identifies videoconferencing directly in his descriptions.

Q. The Ackland patent, though, is just directed to a CMOS photo detector array, right, it's not directed to a consumer product; is that correct?

A. Well, I wouldn't characterize it that way.

It's directed to that imaging chip 27, and at the time, again, remember what was driving these, it wasn't the scientific market.

Scientific market was well-satisfied with CCDs. They didn't care how much they spent.

And that market is relatively small. The number of astronomers in the world is not large. So pretty much everybody working on this was looking towards other applications.

Now, NASA and JPL, they actually had a fairly exotic initial mission, right, that was for telescopes or for spacecraft. But they were looking at the evolution of that as well, and cost in those other markets is a big, big issue.

Q. So Dr. Fossum was doing work for NASA; right?

A. He was certainly at JPL and that was what drove a lot of their earlier -- a lot of their work, yes.

Q. So those imagers that he was working on, the CMOS imagers, were intended to be used in NASA systems, I guess both here and in their different equipment and systems that get launched into space as well; right?

MR. DAVIS: Objection to form.

A. I imagine some of the work he did was probably directed to that. I don't know that all of it was.

And even if it was, I don't know that that limited his vision to only of those applications.

If you look at the -- for instance, the SPIE publications at the time, it certainly didn't appear that he was limiting his vision to spacecraft.

Q. He had a wide variety of applications for that CMOS imager APS, the technology that he was developing?

MR. DAVIS: Objection to form.

A. You know, I'm not Dr. Fossum. I don't want to put myself in his head, but I think that that would be the -- given the article we talked about today would sort of point in that direction.

MR. CAPLAN: Let me take a short break and see if I have anything else because we may be getting close to wrapping up this part of it.

(A recess was taken.)

BY MR. CAPLAN:

Q. Just a couple more questions, Dr. Neikirk.

A little while ago I asked you about starting with Wakabayashi and the different technologies that you could --

that you decided to use for the imager device 27, and you decided to use the Ackland patent; right?

A. Well, I used it in my analysis. I think one of ordinary skill in the art was motivated to use Ackland, to be a little bit more precise, in terms of who did it.

Q. And are you familiar with the CIS technology for image sensors?

A. I've forgotten what --

Q. I think I misspoke. "CID" I think is the right acronym.

A. So CID stands for charge injection device, and in general terms, I've forgotten what the differences are for CIDs, honestly.

Q. So that's not something you considered then to use as the imager device in 27 and Wakabayashi?

A. Again, I wouldn't quite characterize it that way. It was not that I decided to use. I was viewing the art in the

eyes of one of ordinary skill, and I believe the motivation is clear to look to CMOS, and Ackland is an example of that. And in Ackland, since it's a single poly structure, has an advantage of being potentially even lower cost. So to say that I chose not to do CID, I'm just -- that phrasing doesn't seem to be appropriate to me.

Q. Well, why didn't you -- I'm sorry.

Why didn't you consider CID?

A. Well, I think there's a clear motivation for one of ordinary skill.

MR. DAVIS: Objection to form.

A. I believe there's a clear motivation for one of ordinary skill to turn to CMOS and to turn to Ackland, and I didn't then turn to all other alternatives.

Q. Did you do an analysis of any other alternatives besides CMOS?

MR. DAVIS: Objection to form.

A. I looked at a lot of art. Let's put it that way.

I don't recall specifically all of the art that I looked at.

Q. And you testified earlier that you considered CCD sensors to use for image sensor 27 in Wakabayashi and you decided not to use a CCD image sensor; right?

MR. DAVIS: Objection to form.

A. Again, I believe that the way I'd characterize it is I think one of ordinary skill would understand pros and cons, and based on that understanding would turn to CMOS. Not to CCD.

Q. So did you do an analysis, a cost analysis -- let's talk about cost because you've raised that a few times -- a cost analysis for designing a camera in Wakabayashi with CMOS versus CCD, did you do that cost analysis?

A. So --

MR. DAVIS: Objection to form.

A. So I did not do a specific cost analysis.

Again, I believe one of ordinary skill at the time would have recognized

that there was a cost difference and that that is motivation to turn to the CMOS literature as opposed to the CCD literature. But, no, I did not try to price out every component. That would be difficult to do for Wakabayashi because some of those components are standard ones to look up the price for. But, no, I didn't do that.

Q. And did you do any kind of an analysis on Wakabayashi about a trade-off of noise between a CMOS sensor and a CCD sensor and the cost of those?

MR. DAVIS: Objection to form.

A. Again, given the area of apparent application for Wakabayashi, I think one of ordinary skill would have been well aware of the differences between CMOS and CCD.

And someone with experience in imaging systems would recognize that the lower noise characteristics of CCDs were probably not an issue for this application.

I did not do a formal analysis

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of looking up the minimum detectible power for CCD to compare it to the minimum detectible power of CMOS. I don't think that was required.
Q. And why would someone recognize, as you put it, that the lower noise characteristics of CCDs were probably not an issue?
A. Because we've already talked about that extensively.
In low noise environments, those are environments that are dark. And it's pretty clear that this is not about taking pictures of the dark sky.
I think this is, again, something that one of ordinary skill would clearly recognize.
Q. If using a CMOS photo detector array in Wakabayashi's structure was, I don't know, 10 times more noisy, the noise ratio was 10 times worse but it was only, I don't know, 5 percent less expensive, would a person of skill in the art be motivated to use a CMOS photo detector array in that

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circumstance?
MR. DAVIS: Objection to form.
A. Well, I haven't done that specific analysis, but if by 10 percent worse, I think you said it was 10 percent worse --
Q. 10 times worse.
A. 10 times worse in terms of noise 4. If your standard of comparison was a high performance industrial or scientific instrument CCD, then, yeah, actually, I think they'd be more than happy to take the 10X hit because the noise 4 is already so low it's irrelevant.
Q. Yes, but you characterized Wakabayashi as a consumer camera device; right?
A. I think that is pretty clear that that's what Wakabayashi was thinking about.
Q. So that that example applied to Wakabayashi, 10 times worse signal to noise, but 5 percent less expensive, would you use the CMOS in that circumstance?

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MR. DAVIS: Objection to form.
A. You'd use the CMOS because the 10 percent or 10X in signal and noise 4 was irrelevant, so why not pick the 5 percent cheaper circuit or device.
Q. Have you done those analyses, comparing the changes in signal quality versus the cost to figure out what kind of an imager you would use?
MR. DAVIS: Objection to form.
A. No, I've not done a formal analysis. Again, as I've said repeatedly, I believe one of ordinary skill in the art who knows anything about image systems are well aware of these differences, and I will point out that these are for video systems.
The noise 4 requirements for video are much less important than for still photographs because in video everything is moving around anyway.
So anybody who does imaging system designs knows these differences. They understand the difference between still and video. They understand when

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noise 4 matters and when it doesn't.
And a consumer grade video camera is simply not one where you need the noise 4 of a scientific grade CCD, and I believe one of ordinary skill in the art would have recognized that.
MR. CAPLAN: I think I may be just about done. I'll see if there's anything else.
BY MR. CAPLAN:
Q. You said a number of times that this noise is being the big issue. Is that the main criteria you focused on in terms of what type of photo detector array you would use in the Wakabayashi design?
MR. DAVIS: Objection.
Form.
A. No, I wouldn't characterize my testimony in that manner.
I think what I tried to point out is that cost is probably more important. When you have the noise, it's most likely irrelevant. Not a factor to consider because in this -- in a well-lit

video environment, the noise 4 is just not very important.

Q. So it's your testimony that in evaluating Wakabayashi and how a person of skill would understand Wakabayashi, cost would be the main factor in the choices you would make in understanding Wakabayashi?

MR. DAVIS: Objection.

Form.

A. Again, I don't think that's really an appropriate way to characterize my testimony.

Wakabayashi provides certain levels of detail about a system and an overall structure: The housing, the rotatable camera head and so on.

He has left as a design choice the particulars of the sensor -- of sensor chip 27 -- let me make sure I'm using the right number -- yes, of 27. And then particulars of exact circuited implementation for other things. He's called out general functional requirements.

I believe that one of ordinary

skill is motivated to seek out further detail. That's why you use the literature, the other patent literature or any other literature, and use their knowledge, their common sense for a consumer product, one would seek lower cost options, where possible.

They would use their knowledge that in this kind of application noise is probably not the determining factor. Size is relevant.

So if they had the choice between something that was very large and something that was smaller, it seemed to me that they would likely look into the smaller options.

But, in particular, to the image sensor 27 image device, solid-state image device, I think it's clear that that would lead you into the CMOS literature.

And Ackland is an excellent example of CMOS system, where he was saying his advantage was to keep it as simple as he could by using single poly versus

multiple poly layers.

Q. So if consumers would accept more noise for less cost, that would be reflected in the actual market in '97; isn't that right?

MR. DAVIS: Objection.

Form.

A. Well, I actually think the situation is, if consumers ever even noticed the noise at all.

So there's the trade-off between usually image quality and cost. The lenses, for that matter.

A good photographic lens or cinematography lens costs thousands to hundreds of thousands of dollars. Why bother? Because in that application, in the one where somebody picks that lens, the quality of the image is overwhelmingly important to them.

But in most consumer applications, the lenses used, for instance, are pretty inexpensive. They produce acceptable images. Most consumers

never know the difference.

Similarly, if the noise 4 is low enough, which I believe pretty much any CMOS sensor at the time would have been, for a videoconferencing application, then they pick that because it's less expensive.

Q. So consumers would be the ones to really determine what the market would accept in connection with noise and cost.

It really would be consumers in the market?

MR. DAVIS: Objection.

Form.

A. Well, I think -- I mean, you know, consumers -- there are different consumers who have different objectives, but I think it's pretty common for a consumer to get something that works well enough for them that's the cheapest they can get.

Q. That would be common sense.

So common sense would be if cost is an issue, less parts, easier manufacturing would be the way to go?

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MR. DAVIS: Objection to form.

BY MR. CAPLAN:

Q. That would be common sense; right?

A. So you put in "less parts." Sometimes true, sometimes not.

As I explained earlier, when you do a system design, the partition and the part count, it is not universally true that smaller part count leads to lower cost.

And one of ordinary skill and with an electronics background would know that.

MR. CAPLAN: Okay. I don't have any more questions at this point for today.

MR. DAVIS: I may or may not.

Let me take 10 minutes here.

(A recess was taken.)

EXAMINATION BY

MR. DAVIS:

Q. Dr. Neikirk, I just have a couple of questions.

Can you direct your attention to Figure 4 of Wakabayashi.

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A. I have Figure 4 in front of me.

Q. Do you see that it's labeled as element 22?

A. Yes, I do.

Q. What is element 22 in Wakabayashi?

A. So -- let me look. So 22 is called out as being the video camera.

Q. And inside of Figure 4, do you see element 29?

A. Yes, I do.

Q. Is that the circuit board 29 that has been discussed at some point today?

A. Yes, it is.

Q. Can I direct your attention to column 9, lines 18 to 21.

A. Yes, I'm there.

Q. Do you remember a discussion today about the location of where camera circuit 102 is?

A. Yes, I do.

Q. And can you read aloud lines 18 to 21 starting with "the camera head 100."

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A. There it is, 18.

"The camera head 100 and the camera circuit 102 surrounded by dotted rectangles" -- and this refers to Figure 22 -- "surrounded by dotted rectangles constitute the video camera of the present invention."

Q. Is that referring back to the video camera 22 that we discussed earlier?

MR. CAPLAN: Objection to form.

A. So, yes, it is. 22 is identified as the video camera and the numbers from the circuit diagram that we were using earlier as Figure 22 and 102. I do see that, yes.

Q. Let me rephrase the question.

To what does the video camera of the present invention in column 9, lines 18 to 21, refer to?

A. So the video camera there would refer to video camera 22, which we saw in Figure 4, and that contains circuit board 29.

Q. Does that inform your opinion as

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to where camera circuit 102 is located?

MR. CAPLAN: Object to form.

A. Yes, it does.

Q. How so?

A. Given that Wakabayashi has clearly stated that block 100 and 102 are both in the video camera, and then has furthermore said the video camera is as shown in Figure 4, then those circuits -- whatever the circuit is for block 100 and circuit -- for block 102 would have to be on the circuit board or a component on the circuit board.

Some of that could be inside the 27, but that's all got to be connected to board 29.

Q. Do you see later on down in column 9 around lines 46 to 47, where it says -- actually, can you read that aloud, that sentence?

A. So in column 9, starting at line 46, it says: "When the video signal 103 represents an upside down image, this image should be converted to an upright image."

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Did you want me to keep reading? I'm sorry.

Q. That's fine.

And referring to Figure 22 that you referenced earlier.

A. I have Figure 22 in front of me.

Q. Do you see element 103 that you just referred to, video signal 103?

A. Yes, I do.

MR. CAPLAN: Objection as to form.

A. So 103 is -- is the output leaving the camera circuit and going onto the other circuit.

Q. What does it connect to?

A. So it connects to the block 104, which is further discussed in this -- in this section of column 9, where he's discussing how to invert the image.

It also goes to other locations, including a video signal output, a video recording unit, a video monitor unit, so those are other places it goes.

Q. Do you know whether that block

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104 that you had just referred to is within or outside of the video camera that you referenced earlier?

MR. CAPLAN: Objection as to form.

A. So because it clearly states above that the signal -- so the -- we just discussed that 100 and 102 are on circuit board 29. They have to be.

It states that the video signal has now been generated.

Up above -- let's see. That's a description of 103.

It clearly states that the video camera consists of everything inside of the dotted lines around 100 and 102. So what's in the dotted lines labeled 104 is not included in that.

The only other circuit board of Wakabayashi is 39. So this circuitry would need to be on 39.

Q. When you say "this circuitry," what are you referring to?

A. I'm referring to the circuitry

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to provide the functions of 104.

Q. Can you turn to column 6, lines 7 to 10.

A. I'm there.

Q. Can you read that sentence aloud?

A. So it says: "The circuit board 39 includes a signal processing circuit for the video camera in unit 5, a driver circuit for liquid crystal panel 38, a systems circuit, a power supply circuit and so on."

Q. Do you see that language, "signal processing circuit"?

A. I do.

Q. What is that referring to?

A. Well, one example of signal processing, the video signal processing is given in Figure 22, the circuitry inside 104 is a conversion, so that would be an example of signal processing of a signal processing circuit.

It is processing that video signal to invert it.

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MR. DAVIS: No further questions at this time.

MR. CAPLAN: Just give me a minute. Should be 5 minutes or less.

(A recess was taken.)

FURTHER EXAMINATION

BY MR. CAPLAN:

Q. I have just a couple of follow-ups from that.

You agree that the output of circuit 102 is a TV signal format; right?

A. So I believe that -- let me get to my copy of Wakabayashi.

And you're asking about the output from 102 that's labeled as 103, and I believe Wakabayashi calls that --

Q. I think we're in column 9 before --

A. Yes. For instance, at line 22, he identifies the video signal 103, and it talks about -- this is about the circuitry to do the inversion.

It shows clearly in the diagram that 103 is fed to a video signal output,

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so -- I'm sorry, your question was again?

Q. You agree that the output of circuit 102 is a television signal format; right?

A. It is certainly a video format as identified -- I don't know that Wakabayashi says "TV."

Q. If you look in column 9, it looks like lines maybe 14 to 18. If you can take a look at that.

A. Yes. Yes, it does say -- I think I read this earlier out loud, yes, "video signal 103 is a television signal format." Yes, I see.

Q. Right.

And earlier you testified that circuit 102 is on board 39; is that right?

MR. DAVIS: Objection to form.

A. I believe what I said -- and at the time I didn't -- I knew I was looking for this. I was concerned I had missed something.

At the time I said that, it would make sense to put the conversion to

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video elsewhere, but clearly it's not on 39. The figures and the text we just talked about, it is shown as being in the video camera, and the video camera, the only circuit board in it is 29.

Q. But you did earlier testify that circuit 102 was on board 39; right?

MR. DAVIS: Same objection.

A. I believe what I said was that not being able to puzzle out, I could tell for sure that 100 was on 29.

I think I probably said that it either made sense or it likely would be the video conversion could take place on 39.

If I said it was on 39, clearly that was not correct.

Q. Well, you said it was an explicit disclosure was on 39.

Do you recall that?

A. Of the conversion to the image processing? If I said that, then I was simply wrong.

Q. So were you wrong then or are you wrong now? Which one is it?

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MR. DAVIS: Objection to form.

A. It's very clear from the description that the signal 103, which is video, television format, is leaving the video camera, and it is quite clear that the video camera contains circuit board 29 but not 39.

MR. CAPLAN: No further questions.

Thank you, Dr. Neikirk.

(Time noted: 6:12 p.m. EST)

_____
DEAN NEIKIRK, PH.D.

Subscribed and sworn to before me this ____ day of ____ , 2020.

_____

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C E R T I F I C A T E

I, Linda J. Greenstein, Professional Shorthand Reporter and Notary Public in and for the State of New York, do hereby certify that, DEAN NEIKIRK, PH.D., the witness whose deposition is hereinbefore set forth, was duly sworn and that such deposition is a true record of the testimony given by the witness to the best of my skill and ability.

I further certify that I am neither related to or employed by any of the parties in or counsel to this action, nor am I financially interested in the outcome of this action.

IN WITNESS WHEREOF, I have hereunto set my hand this 5th day of October 2020.

Linda Greenstein

Linda J. Greenstein

My commission expires: January 31, 2021

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I N D E X

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(Exhibits retained by counsel)

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DEPOSITION ERRATA SHEET

Our Assignment No.: 1038
Case Caption: Samsung v. Cellect, LLC

DECLARATION UNDER PENALTY OF PERJURY

I declare under penalty of perjury that I have read the entire transcript of my Deposition taken in the captioned matter or the same has been read to me, and the same is true and accurate, save and except for changes and/or corrections, if any, as indicated by me on the DEPOSITION ERRATA SHEET hereof, with the understanding that I offer these changes as if still under oath.

_____
DEAN NEIKIRK, PH.D.

Subscribed and sworn to on the _____ day of _____, 20 _____ before me.

_____
Notary Public,
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