CG GARAGE PODCAST #284
DOUGLAS TRUMBULL
DIRECTOR/VISUAL EFFECTS SUPERVISOR

Douglas Trumbull, the genius behind the visual effects of “2001,” “Close Encounters” and “Star Trek,” on his 50-year quest to understand and improve cinema.

Over the past 50 years, Douglas Trumbull has pushed the boundaries of filmmaking via stunning effects in *2001: A Space Odyssey*, *Close Encounters of the Third Kind* and *Star Trek: The Motion Picture*. Today, his intricate understanding of cameras and projects has resulted in the Magi format, which promises gorgeous high-framerate films without the soap-opera look.

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Useful links

Douglas Trumbull on IMDb

Trumbull Studios: The Magi Process on YouTube

Chris: This has been a long time that I've been wanting to do a podcast with you, I've got to tell you!

Doug: Well, this is great. I'm glad we've finally pulled it off.

Chris: Yeah, me too.

Chris: Obviously, when we first met, we were in the throes of doing that “Construct” project. And we were excited about thinking about doing the Magi system, which we will talk about; how we took one minute of video and rendered the equivalent of 40 minutes of video, to get it done for Magi.

Doug: Right.

Chris: Which was quite amazing, to do that.

Chris: But I'm sure, based on my audience, that my audience is really going to want to learn a little bit more about you and your history. And obviously, you have so many incredible stories; every time I talk to you to tell me some awesome stories. And so, I'd love to start with some of those things, and I've actually been reading a little bit about it to refresh myself.

Chris: I'd love to know what got you into this? What was the thing that inspired you, at the early stages, that said, "I want to get into making movies or doing that kind of stuff."?

Doug: Well, my father was in the movie business, way before I was invented or conceived. And he had worked on the *Wizard of Oz*, way before I was born.

Chris: Oh really?

Doug: Yeah. So that was a little bit of lore, in my family, that my dad had done that.

Doug: But there were a lot of weird tribulations going on in the movie industry at that time, in 1942, where there were a lot of strikes and walkouts. And then all of the problems going on with World War 2, and the Japanese attacking, and Germany; I mean, the whole world was a mess.

Doug: My father decided to leave the movie industry and go into the aircraft industry, which, I never heard the details of why he made that decision but I can understand it now, in retrospect, because it was a huge war effort. And it wasn't much further to drive to Lockheed, in the valley, than to drive to MGM in Culver City.

Doug: So, yeah, that's what happened, he left the movie industry. And then I got into the movie industry. And then, for whatever reason, my father, Don Trumbull, made sure I saw what was going on. He had movies he wanted me to see; took me to

them; I saw them. And then he took me to every special film format known to man; as soon as Cinerama opened, he took me to Cinerama; as soon as D150 opened, he took me to that; as soon as Todd-AO opened with *Around The World in 80 Days*, he took me to that. And so I had this little upbringing as a child, about being immersed in special film processes, and things like that.

Doug: Because I was a young ... When I was in high school I was really interested in science fiction. I had this kind of alternate fantasy life that I lived, reading Heinlein and Clarke and Asimov and stuff. Because my family was a disaster; it was just a completely unmitigated disaster. Because my mother had died when I was seven, my father couldn't handle it. Everybody in the family was Christian Science, and that's why my mother had died, because she didn't get medical help.

Doug: And my father ripped me and my sisters out of the entire extended family, so I lost all my uncles and aunts and cousins and everything. So I became a kind of a misfit, loner, trying to figure out how to survive. Nevertheless, I had this fantasy life of reading science fiction, through junior high and high school.

Chris: Right.

Doug: And when I realized that I actually had artistic talents, because my mother was a commercial artist, my dad was an engineer, I started painting alien planets and spacecraft and things like that, in my little portfolio. I went to El Camino Junior College in L.A. for a couple of semesters; it really wasn't serious. But I had classes in life-drawing and a little more structured artwork; so charcoal, pastels, watercolor, gouache, oils. And so my portfolio was filling up with alien stuff.

Doug: And because one of the other things that my father made sure that I saw was everything about animation, and all these special shows that were on every Sunday night with Walt Disney, telling me about the multi-plane camera for *Pinocchio*, and all these kind of technical aspects of movies and animation. And so, I was getting this kind of online education, even then.

Doug: And I decided, because we had no money and I was just barely getting by, I did that brief stint at El Camino Junior College, and then I actually did one semester at ArtCenter School of Design in L.A.-

Chris: Okay. Yeah, yeah.

Doug: ... which was a fantastic place.

Chris: Yes.

Doug: So I got a little more honed in my drawing skills, and that was a professional art school. But I had to get a job, and so I decided, well, I'm going to go try to get into the animation industry. The word on the street that I heard from friends was that

if you wanted to go to Disney for example, the only entry point for Disney was as an inbetweener.

Chris: Right. Yeah, yeah, yeah.

Doug: So some artist would paint Frame 1, and the other artist would ... Or he would paint Frame 1 and paint Frame 3, and you would have to paint Frame 2.

Chris: Right.

Doug: And I said, "I am not going to do that. It's just, like, too beneath my vision of myself to go be an inbetweener at Disney." So I took my portfolio, and started dragging around L.A., looking for a job. I went to several animation studios, I can't remember the names of them now, but they made *Mr Magoo*, and many other animated television shows.

Doug: So somebody said, "Well, you know, Doug, you're a misfit, and this is not the right job for you. But there is this place across town that does space films for NASA, and I think you might be a fit there." So I got directed over to Graphic Films. And I went over there and showed them my portfolio, and I met with who would become my boss, Con Pederson, who later joined me, and we worked together on *2001*.

Doug: So he said, "Well, Doug, go home and paint this little satellite." And I said, "Okay." So I took this little satellite drawing home and did a little painting for it, brought it in the next day, and got my job at Graphic.

Chris: Okay.

Doug: So I started working up through the ranks at Graphic Films. I started as what they call a background illustrator, and then I started doing pretty much everything for a lot of different films.

Doug: And then they got a job, Graphic Films got a job to do a film for the New York World's Fair, which was going to be in 1964, and this was a special film on a domed screen, a 70-mm film, each frame of film was circular, and a 10 perforation, 70-mm film. I was working on this film with Con, and other people at Graphic, and that was a total gas for me; I was just doing all these paintings of stars and planets, and various kinds of artwork that depicted biological materials, and the cosmos, galaxies, and all kinds of spacey stuff. And that was shown at the World's Fair.

2001: A Space Odyssey

Doug: Then, Stanley Kubrick and Arthur Clarke saw that film at the Fair and called Graphic Films, because they had *2001* in mind.

Chris: Right, right, right.

Doug: So Graphic Films got this job to start doing some preliminary conceptual artwork for *2001*, very early on. And I was working on that stuff. And that was all being sent to Kubrick in New York. And that was going pretty well. I was pretty excited, I mean this was the guy that did a lot of amazing movies.

Chris: Oh yeah!

Doug: And I'm just thinking, this Kubrick guy must be completely amazing. And I think this movie looks like it promises to be amazing, and incredible.

Doug: So Kubrick decided that he was going to go make the movie in England, and that communication between L.A. and England was going to take forever; no one had invented a fax machine yet. So he just terminated the contract with Graphic and said he was moving on, and he would go ahead and make the movie his way in England.

Doug: And for whatever crazy reason, I was a very precocious street kid because I was on my own all the time, making my own way, and so I called Con, I said, "Con, I want to call Kubrick and ask him for a job." And he said, "I can't tell you his number because it's secret, and I'm under an NDA." I badgered him a lot, and he finally said, "Well, I can't tell you. But I can tell you that Kubrick's phone number is penciled in the lower corner of the bulletin board at the office."

Doug: And so I actually drove to the office, I could get in the backdoor, and I got Kubrick's number. And I just cold-called Stanley Kubrick, and said, "I've been working for you. My name's Doug. I've been doing these illustrations, and I would love to work on your movie." And it took a couple of days, and I don't know who ... He must have called Con, or called Les Novros or something, and said, "Who's this kid?" Nevertheless, Kubrick sent me airfare and reservations for me and my wife to go England, like, right away.

Chris: Wow!

Doug: It took me a couple of weeks to unravel my life, and get rid of my possessions, and undo my lease on an apartment I was living in at Hermosa Beach.

Doug: So I went to England to work on *2001*. And started, fundamentally, in the animation department; I was kind of running the animation department. At that time, no one really knew ... I mean, this was a big R&D project, *2001*. And so the

reason I'm telling you all this is that, we started out with very simple, very orderly tests that Kubrick wanted to see, and one of the tests was stars. He said, "Well, this movie's going to be stars all the time." And I had done lots of stars at Graphic, and I had worked out a way to spatter white paint onto glossy black paper at Graphic Films, and make really good-looking stars. They weren't real constellations but they looked incredible.

Doug: And so, we did these tests of stars on the animation stand. We had an Oxberry animation stand that could shoot one frame at a time. Okay? Very simple.

Chris: Yep.

Doug: We started tests, and said, "We've got to have stars moving left to right, stars moving right to left, stars moving up and down, and stars moving diagonally, at different speeds. Let's just kind of see what we like."

Doug: And there was a really interesting process that we used with Kubrick, throughout the production, which was double projection in the screening room. Like, if we had a spacecraft photographed on one piece of film, we could have stars photographed on another piece of film, and just do a comp on the screen by projecting them, both, simultaneously.

Chris: Interesting. Yeah.

Doug: So that was one way we did quick temp comps to kind of get a feeling for weird things that Kubrick was trying to discover. Because he said, "How do I create a sense of weightlessness?" And we found out that if you moved the spacecraft in one direction, you would move the stars 90 degrees on a different axis, and it would create this very nice floaty kind of feeling. So that pervades the whole movie.

Doug: Anyhow, we're shooting stars, and he said, "Well, let's make it a little faster. Let's make it a little faster. Let's make it go faster," which we did, showed him in the screening room. And one day we started seeing double stars at certain speeds. And I said, "Why are we seeing double stars? I didn't shoot double stars, it's not a double exposure. Look at the film, there are individual stars there."

Chris: Right, right, right.

Doug: And what evolved out of that was the beginning of my quest, which I've been on for 50 years since then, to figure out how movies work. Because what happened was, the double stars were being created by the double-bladed projector shutter.

Chris: Oh right, right, right.

Doug: Okay? Each frame was being shown twice, and then it would go to the next frame and show that frame twice. And that was being stored in the retina of your eye, of

everybody's eye, and it's called persistence of vision; it's how movies work. Okay? So tell me if I'm getting too dry here, because this is-

Chris: No, no, no, no. I know where we're going, so this is a great.

Doug: Well, fortunately, I ... You know where we're going!

Doug: So this led to ... First of all, everything in *2001* was slowed down so nothing juddered. There was no doubling imaging at all. Kubrick just said, "Okay, we're just going to move everything very slowly, and be very cautious about it. I don't want to see the double stars." Because we knew double-bladed shutters were baked into all the world's projectors, and we had nothing we could do about that.

Chris: Right.

Doug: So that was phase one of my little learning process of trying to understand how movies work.

Doug: And then, one of the next things that happened, which was really fascinating, was, Kubrick was a very capable still photographer, and he wanted the spacecraft in the movie to be sharp as a tack, and look really super-detailed. And he said, "We're going to do that with strobe lights." Nobody knows this story, it's not been written up. We had these days of shooting the camera moving very slowly past the spacecraft, it would make it look like the spacecraft was moving.

Chris: Right.

Doug: With strobe lights on every frame. And the result of that, on the screen, looked like a cartoon. This is lesson two. You have to have blur-

Chris: Motion blur? Yep.

Doug: ... you have to have motion blur. So he said, "Okay, I give up. Let's do motion blur. Movies have been that way forever." And so, we started using our motion control cameras for miniatures, where the camera is moving continuously, even though it's a three-second exposure for depth-of-field. There was enough blur, because it's a 180 degree shutter, closed half the time, open half the time.

Chris: Yep.

Doug: And that looked fine on the screen. Okay? As long as it moved slowly, and didn't have too much judder or anything else.

Doug: So that was another lesson in the basic fundamentals of moving pictures on-screen, is blur, which you're certainly familiar with.

Chris: Sure.

Doug: And this led to my realization that each frame is being shown twice and it's blurred, and that actually there's a problem with that, because there's no continuity. If the movie has been filmed at 24-frames-a-second, it should be shown at 24-frames-a-second, and then it should look nice. But it doesn't, it flickers very badly. That's why the double-bladed shutter is there, to get rid of flicker. Okay?

Chris: Right.

Doug: So that's the way movies have been for a hundred years, whether they're silent films or talking films, 16 frames-a-second, or 24, there's a double-bladed shutter. In the old days of the silent films they had a triple-bladed shutter to get rid of the flicker. But that's where the term "flicker" or "flicks" comes from, and that's the core meaning of Netflix, which means "movies on the internet." Okay?

Chris: Yep.

Doug: Okay. So this is lesson after lesson after lesson!

Doug: Many years later, I started a company with Paramount Pictures called Future General Corporation, which was a little research and development arm of Paramount, for the purpose of exploring the future of cinema and entertainment. They would give us limited amounts of money to do experiments that I wanted to do, and it was like a no-questions-asked deal. It was really fascinating, quite extraordinary at the time. But I could just write a letter to a lawyer at Paramount, and say, "I would like my 25,000 dollars to experiment with "X" or "Y".

Chris: Yes. And it was a grant of some kind, right?

Doug: We'd automatically get this grant, and we would start doing our thing, with nobody asking anything. The whole thing was a tax write-off scam at Paramount, because they owned 80% of the company so they could write all of it off. So there was no risk, no loss of money, no nothing. And it was a really terrific opportunity to explore something in a way that nobody in L.A., or the movie industry, really wants to do research and development.

Chris: Sure. Sure, sure.

Doug: So, we ... My partner, Richard Yuricich and I, you probably know his name?

Chris: Yeah.

Doug: He and I, we've worked together for many years on all these movies. And we decided, well, we're going to look at every film format anybody has ever made, and we've got to figure out what's been going on: Todd-AO, D150, Techniscope, Technirama, Cinemascope, you name it ... VistaVision, et cetera; we'll try them.

So we would rent cameras, we would rent lenses, get some raw stock, shoot some tests, and then project them with the appropriate projector on various sized screens.

Doug: And we went through this exercise with double-bladed shutters in every one of these projectors, and we came to the conclusion that there was nothing really fundamentally different about any of them. There was a little difference to the frame size, so you'd get a little sharper image if it was 70-mm rather than 35, or IMAX rather than 70-mm. You could increase the resolution of the image, but you didn't solve any of the fundamental problems of blurring, judder, strobing, and flicker.

Doug: So Richard Yuricich and I decided to try, we said, "Well, the only thing we have not tried is frame rates. Why is the frame rate, 24, or anything else?" So I started looking at frame rates and everything, and one of the things I found was a little document about Edison's movie experiments. And he had concluded in his early experiments that 48-frames was the way to go, it was ideal, for whatever reason.

Doug: And I've got to find this, too, because I'm on this same trek and I've got to prove this again. So you've got Edison saying 48-frames, and then you've got the Lumiere brothers saying, "Well, if you just put a double-bladed shutter on, you show each frame twice, and you only use half the film." So it's about saving money, it's about saving raw stock, it's about saving print costs by going to 24-frames with the double-bladed shutter. So that's been with us, in the movie industry, for almost a hundred years. Okay?

Chris: Right.

Doug: So jump to more near the present day, when Richard Yuricich and I did some experiments with a process we called Showscan. We did tests of all these different frame rates in 35-mm film, and showed these individual tests to individual people, and hooked the individual people up to electric cardiogram, electromyogram, electroencephalogram, and got a skin response for fundamental physiological sensors on their bodies while they watch these movies. And the movies are all identical, except the only difference was frame rate.

Chris: Okay.

Doug: And we found this perfect kind of bell-shaped curve, like you see with Coronavirus, that starts peeking out about 60 to 66-frames-a-second. And that was a big discovery. And that became part of our patent application for the Showscan process, which was 65-mm film, 70-mm prints, at 60-frames-per-second, for a very large Cinerama type screen, using film. Okay?

Chris: Sure.

Doug: It was fantastic. And everyone who looked at it was highly impressed. Many people commented, they said, "This is like 3D without glasses, it's so vivid and so realistic that it's really powerful."

Developing Showscan

Doug: So we formed the Showscan corporation under Paramount, and went ahead making movies for theme parks, and expos, and things like that. We were competing directly with IMAX.

Chris: Right.

Doug: And we had a better image on the screen at 60-frames-per-second that IMAX had at 24, even though their film stock was bigger-

Chris: Much bigger!

Doug: ... projectors were bigger. What we realized is that frame rates trump ... And I hate to use the term Trump! Frame rates are more important than resolution if you want human stimulation.

Doug: I realize, now, in retrospect, going back to those days of Showscan, that the fact that there was actually a shutter in the projector but it closed only once, you saw each frame only once, but there was a shutter; it was the shutter that was making the movie look like cinema. This was a fundamental discovery. And that's why I'm trying to get to this with you, right now, Chris, because it's that fundamental shuttering that defines cinema. Whereas, television has no shutter.

Chris: Right.

Doug: Okay? There's no shutter on this right now, with the Squadcast, or whatever, or on a laptop, or any digital media, there's no shutter. And so, over the years, we've been all watching movies in theaters, and we've all been watching television on our television screens. And we know it when we see it. And we know that we do not want to go to a movie theater to see a television show. But we know that it actually works to take a 24-frame-per-second movie and stick it on television; it actually works okay, the story comes through, it all works okay. Because the frame rate of television is 60, or 50 in the U.K. and other countries.

Doug: But it's these fundamental things about frame rates, and how many frames you show, and how you show them, that has been fundamentally misunderstood and

improperly implemented for almost a hundred years. So tell me if I'm getting too dry again, but I will carry on.

Chris: No, it's good.

Doug: Okay.

Doug: Where we end up is that, I discovered when I was watching the development of digital movie projectors, okay, a digital movie projector is quite a different animal from a film projector. A film projector has ... A film that's stopping and starting in the gate, as soon as the film stops in the gate, the shutter opens up and shows you that frame, and then it advances to the next frame, and it shows you that frame, twice.

Doug: In a digital movie projector, they're using this digital light processing technology, the DLP thing, which is that instead of the gate being in the projector with a frame of film, and all that resolutionary image for that moment in time, which includes a certain amount of blur; the digital projector has thousands of little micro-mirrors that are wobbling, very, very fast, extremely high frequencies. They're not going off, and there is no shutter, they just change state from one color to another color, or one brightness to another brightness, by just twisting a little bit. Because the micro-mirrors are mounted on a little magnetic field on a little rubber mount, and so they're modulating the colors and brightness of every pixel that goes to the screen, which is reflected light off this thing.

Doug: So I started studying, well, how did that work? Because how could you understand how it could take a 24-frame-per-second movie and project it with a digital projector? And what I found was that they were taking each frame of film, putting it through the micro-mirrors, and changing the state of the micro-mirrors five times a frame. No shutter, but a little different position of the micro-mirrors every time it's shown on the frame, on the projector.

Doug: The other thing that happened shortly after that was the advent of 3D digital projection, which was quite revolutionary. It enabled *Avatar*, and a lot of other 3D movies. What's going on with 3D movies is instead of showing each frame five times, it shows each left-eye frame, it shows it three times, and the right-eye frame, it shows it three times, and it interleaves them, left, right, left, right, left, right; it's 144 cycles a second; very fast. Okay?

Doug: So when you project the left eye three times, and the right eye three times, and you interleave them on a screen, you're just creating headaches. Your mind doesn't see the world that way, that is not the way anything's been, and it's worse than the double-shuttering of film which we all grew up on. And then, you add to that the problem that in order to enable 3D you have to alternate the left eye, right eye, by sequencing it somehow, and so that either requires polarizing filters or active shutter glasses or something like that.

Doug: So basically, at the projector you're introducing a filter that's cutting the light in half. So if you started with 14 foot-lamberts, you end up with 7. And then, you put the glasses on, which have filters, and you cut the light in half again, and so you end up with maybe three, three-and-a-half foot-labyrinths.

Chris: Right.

Doug: And in general, the movie industry accepted this wacky, 3D thing, of all this double flickering of left eye and right eye, and less than three foot-lamberts of brightness on tens of thousands of movie screens, and totally alienated the audience. Because 3D is really cool if it's good 3D; Jim Cameron knows how to do it really well. 3D is also a pain in the neck for filmmakers, and every filmmaker who has done a feature film in 3D, finds out all these traps that you can fall into. Which is that if you move too fast or too slow, you can have all kinds of anomalies, where the stereoscopic space inverts, or this weird stuff that happens. And so, they had to be very cautious about it.

Chris: I worked on several 3D films. It's very challenging.

Doug: So Peter Jackson went through this, big time. And Jim Cameron went through it, big time. And Ang Lee went through it, big time.

Doug: And one of the things that happened, which is more recent, is that Ang Lee came to visit me. By this time, I have this theater behind me, which is where your movie is, at 120-frames-per-second, and each frame is shown only once; 60 frames left eye, 60 frames right eye. And they're perfectly sequenced in temporal continuity, so the exact sequence of photography is identical to the sequence of projection.

Doug: And one of the unique attributes of what I'm doing is that I'm using two cameras, but I'm using the shutters out of phase with one another: one camera shutter is open, while the other camera shutter is closed. No one does this. But if you do this, you open and close them, sequentially. For the first time in the entire history of cinema, we're capturing 100% of what happens for the camera, whereas, all these years, we've only got 50% because the shutter's closed half the time.

Chris: Right. Right, right, right.

Doug: Okay? Now, I can't tell you how disturbing it is for me to have taken so much time out of my career as a filmmaker to solve these stupid problems. But I have, and I've got it working, and it's really quite stunning and amazing.

Doug: And so, Ang Lee came to me. He was referred to me by Dennis Muren at ILM. Dennis knew I was experimenting with high frame rates. So Ang Lee came here to my studio to see what we were doing, and he was completely blown away, "So that's the way we've got to make movies!" Because I was showing him

120-frames, 4K, 3D, on a very big, widescreen. And he said, "Well, that's what I want to do."

Doug: But he misunderstood what I'm doing, and he kind of bought into the Kool-Aid of companies that sell digital projectors, because they could give him this 100% illumination. And if you go to 100% illumination with no shutter, at 120-frames-a-second, it looks like a big TV show.

Chris: Right.

Doug: And so, it's a fundamentally obnoxious experience for anybody who sees it, they really don't like it. And even the 48-frame stuff that Peter Jackson did was rejected by audiences, because 48-frames is just a little below 60, so it looked like television on a movie screen. There's two things going on; there's persistence of vision, which is your brain is linking all these crazy frames together, but there's also suspension of disbelief.

Doug: There's a weird aesthetic, technical event happening when you photograph and project a movie at any frame rate, is that it's a mysterious, other worldly thing up on the screen. And people, if it looks like it should look, they will go with the story, they will get immersed in it, they will buy into it, they'll be affected by it, they'll cry to it, or they'll laugh to it, or they'll be scared by it, or whatever the movie is doing, can be delivered by the movie medium. But if you transgress what people expect, and you try to go something that's even bigger and better by going closer and closer to video; well, that's what you get, is video.

Doug: And so, Ang has done this twice, now. And I like Ang, he's a very good friend of mine, so I'm cautious about saying anything derogatory about what he's doing, but I think he's made a fundamental misunderstanding of how to do high frame rates. He made *Billy Lynn's Long Halftime Walk* at 120-frames.

Doug: And the projector manufacturers, who are trying to sell projection systems to theaters, want to do two projectors; a left-eye projector and a right-eye projector, with different filters on them. Whether they're the dichroic filters, or polarizing filters, or active filters.

Chris: Right.

Doug: And so they are able, in that way, to sell twice as many projectors.

Chris: Yep!

Doug: From the theater owner's point of view, that's like way too expensive, and they don't want to do that. And there's a lot of alignment problems and other things that emerge, when you have two projectors that have to be perfectly aligned on a screen. If they're not, it's another headache producer.

Doug: So the thing that I've been developing with this process I call Magi, which we worked on with your “Construct” movie, is this 120-frames, 60 per-eye, alternating left eye, right eye, in perfect temporal continuity. And the result is stunningly amazing.

Chris: Yeah.

Doug: Just totally amazing. And you can make the screen as big as you want, and there's no blurring, there's no strobing, there's no artifacts of motion that are annoying.

Chris: Yeah. It was something that was very hard to ... Because I have been fooled by the perception of high frame rate for a long time. Because, probably, based on what you're saying, they weren't being done correctly, right? I wasn't very impressed with *The Hobbit*, as you have mentioned, and there are certain things that don't work.

Chris: The other one, actually, I would love your explanation on this. Is, you know the TVs out there that have the 120-hertz motion smoothing that just looks horrible?

Doug: Exactly. Right.

Chris: Explain to me why that looks as bad as it does, compared to natively shot 120-frames, on a real projector, or on a real TV?

Doug: The simple answer is that there's no shutter.

Chris: No shutter.

Doug: You can introduce a shutter digitally, it's so simple, and it costs nothing.

Chris: Okay.

Doug: So if you turn on, or you leave on the motion flow, pixel flow, whatever they call their product, iIt's interpolating a 24-frame-per-second movie, up to 120, or even 240 sometimes. But there's no shutter, and so it takes what is the movie texture and turns it into a television texture.

Chris: Right.

Doug: I don't have any words in my limited vocabulary other than texture. But it's like, you know it when you see it. And so, when you take any movie and project it at a high frame rate like that, it just looks like television. And no one wants it to look like television, because it completely destroys the suspension of disbelief and the natural feeling of an actor or actress being emotional on the screen, and being very vulnerable, or whatever the story is about. But the vividness of it looks like a

soap opera, and so there's a thing that's called "the soap opera effect," and that's a no-no, that's absolutely a no-no.

Chris: Right. All right.

Doug: And unfortunately, with the second movie that Ang Lee made, which is called *Gemini Man*, it's still doing that, it's still no shutter, there's still two projectors. And they've even going further, which is interesting, because there are parts of the whole equation that are wonderful and profoundly important, which is laser projection.

Chris: Right, okay.

Doug: Because they're using dual laser projectors, which are clearer, sharper, the color is a much better color spectrum, it's what they call Rec. 2020, now. And you see things much more vividly; blacks are blacker, reds are redder, blues are bluer. And it's a different color grade that you do, for any movie, for a laser projector.

Doug: It's being sold as a kind of a high dynamic range enhancement of movies by Dolby Labs, and they use it for this process they call Dolby Cinema, for Ang Lee. Dual laser projectors with color grades for laser color space and contrast. And there's no shutter. And they just don't get it! I don't know why they do it. I don't know why they don't understand this. I don't know what I have to say to get their attention to realize that the audience does not want that look. It's just not a good thing.

Chris: To your point, it's doing a disservice to the idea of high frame rates, right? Because it's not the-

Doug: Well, it's been really damaging to me and to my work because people think, well, that's what it is. And I say, "Well, sorry, that is not what it is. You can do it, and you can still make it look cinematic. You want your movie to look like a movie." And there's this weird world of persistence of vision, suspension of disbelief, and another thing called the fusion frequency, which is how our brains can accept multiple frames of film in a sequence, and say, "Oh, I understand. It's a story. It's action. There's stuff going on."

Doug: And in today's world, directors want a tremendous amount of action. They want the camera to move fast, they want the action to be moving fast, and they want to see it all, and they don't like the blur, and they don't like the artifacts at 3D. And so, 3D is pretty much on the skids right now.

Chris: Right.

Doug: And there's another aspect to what I'm doing, which is 2D, 60-frames. If you do 2D, 60-frames, but you make sure there's a shutter, you can introduce dark

frames to make the shutter; it's fantastic. It's like what Showscan was, 35 years ago.

Chris: Right. Well, I remember when you showed ... There was something that was really interesting, that really sort of ... It was the one thing, when I saw it, that it really resonated. I went to the screening at FotoKem, the first time I saw “Construct” at Magi specs. But you had done your own short, which was “UFOTOG.” And it was great. But the thing that really made me go, "Uh!", like it was really amazing, was you had a shot looking into a window.

Doug: Right. Right.

Chris: And so, you were looking through a window, and you saw the characters moving through it. And in the window there was a TV screen that was playing at 24-frames-a-second, and you created the contrast within the same frame, to show you, this is what 24 looks like, and this is what I'm looking at, at 120. And I was, like, "Oh!" And of course, if you do the math, you can do it, because basically all you're really doing is 24-frames-a-second inside of the 120, right?

Doug: Right.

Chris: You're just showing the image five times, and it makes sense. So it totally resonated for me, for that time.

Brainstorm

Chris: When I was a teenager, one of my favorite films was actually *Brainstorm*. I loved that film.

Doug: Oh great!

Chris: And in fact, I have another podcast I do, where it's me and two of my friends, and we're big film geeks. And we did a whole episode just on *Brainstorm*, we talked about it for three hours.

Doug: I'd love to see that.

Chris: I'll definitely send it to you.

Doug: Okay.

Chris: But the thing that was interesting to me, and that we realized when we were researching it, is that *Brainstorm* had those two states of film in there, right? When you were in the *Brainstorm* world, everything was done at 60-frames, right?

Doug: No, actually it was not. That was my plan but I couldn't get the studio to do it.

Chris: Oh really?

Doug: Yeah. So the only thing I was allowed ... That movie was designed for the Showscan process.

Chris: That was I thinking, yeah.

Doug: So I'll backtrack to a little earlier in our conversation-

Chris: Okay, because I want to hear this one, too.

Doug: ... because I was at Paramount, and I had developed the Showscan process. And I'm coming at it as a filmmaker and a director and writer. And we had this screening in Westwood in a theater we'd converted with a gigantic screen and a special projector. Charlie Bluhdorn, who was the head of Gulf+Western, that owned Paramount Pictures, was there, with Barry Diller and Jeff Katzenberg, and maybe a few others, all were there.

Doug: But when the movie ended, Bluhdorn jumped out of his seat, turned to the executives of Paramount, and said, "Gentlemen, if we don't make a movie in this process, we're fools, because this is the future of cinema."

Chris: Right.

Doug: That was a big moment for me, I thought, "Ah-ha! All my problems are solved. Now, we're going to go off into the blue yonder and make wonderful movies." Well, it didn't happen, for a lot of other reasons. And I'm not going to burn up our time talking about that.

Doug: But that was back in the late '70s, of doing 60-frame, 70-mm film. And at that same moment in time, Paramount got all embroiled in the making of *Star Trek: The Motion Picture*. Okay? And they said, "Doug, we're really in a pickle here, we're having trouble with the visual effects. This movie is not working. We really need some help." And they were kind of begging me to come in and help them fix *Star Trek: The Motion Picture*. Robert Wise was directing, and they had the cast, and Nimoy and Shatner and everybody.

Doug: And I said, "No, I'm not here under contract to Paramount to supply visual effects services. I've kind of moved on. I'm a director. But I've also invented this process." The bottom line was that Paramount decided that it was much more important to

them to get *Star Trek* done successfully than to deal with Showscan. This was a huge event for me. They said, "Doug, take your Showscan thing, we're not going to do it. We're closing Future General down; we don't want to do it. We want to do *Star Trek*."

Chris: Okay.

Doug: So I was asked to go into a meeting with Barry Diller, and I don't know who else was there, Michael Eisner might have been there at the time, my lawyers, their lawyers. And they said, "We are in such a pickle, because this movie's production has been paid for by the exhibitors under a program called blind bidding, where they pay in advance for the rights to show a movie." Okay? You see, these are the kind of stories that very few people know about.

Chris: Yeah!

Doug: So I'm there, and I said, "What's blind bidding?" And they said, "Well, the movie has been paid for by others. And if we don't deliver the movie to them on December 7th of this coming year, they're going to file a Class Action lawsuit against Paramount Pictures and close us down, and close all our theaters, all the theaters booked for the movie for the Christmas holiday; they're just going to close the theaters-

Chris: Wow!

Doug: ... because the movie they've paid for is not there." And so, that was just going to, basically, put Paramount Pictures out of business.

Doug: And so I was told, they said, "We've got to get this movie done. We don't care what it costs, we don't care how long it takes, but we need you help getting the movie done." So I said, "Okay. I will set everything in my life aside and I'll go fix this movie for you." That was my job. And that was what happened.

Doug: But it sprung *Brainstorm* and Showscan free of Paramount, they dropped the ball. So I was out looking for another studio to make *Brainstorm*, not at Paramount. And I don't know if you know about the whole scandal that went on, during the years that David Begelman was at Columbia Pictures?

Chris: Mm-mm (negative).

Doug: Well, this was really fun. I was working with Steven Spielberg at Columbia Pictures doing *Close Encounters*, under a sub-contract to them, that Paramount had agreed to, this was previous to the *Star Trek* problem, to do the visual effects for *Close Encounters*. So Richard Yuricich and I were doing the visual effects for *Close Encounters*. And that was all going just fine.

Doug: And what I'm trying to lead to with that, is that Columbia got *Close Encounters*, David Begelman was running Columbia. David Begelman embezzled a check sent to Cliff Robertson. Cliff Robertson found out about it, never got the money, and filed a lawsuit against Columbia Pictures for embezzling.

Chris: Okay.

Doug: So it's a long story. But anyway, this whole story is told in a book by David McClintick called *Indecent Exposure*. This is an amazing story of behind-the-scenes Hollywood that you just won't read anywhere else.

Chris: Yeah.

Doug: Anyway, David Begelman got in hot water. It was a huge scandal on Wall Street. Columbia Pictures was teetering on the verge of some kind of huge scandal that would adversely affect their stock. But at the same time, *Close Encounters* was just about to come out, and they all knew it was going to be a blockbuster. They all knew that we had done this amazing thing. So, *Close Encounters* came out, it was hugely successful, but David Begelman got ousted from Columbia Pictures. The board of directors said, "You are out of here. We've got to get you away because you're scandalizing our company." I don't know the details of how it happened.

Doug: Anyway, David Begelman, the embezzler, ended up at MGM, running MGM. Calls me because I had saved his butt on *Close Encounters*, and said, "Do you have any movies that you'd like to make?" And I said, "Yes. I happen to have this movie, *Brainstorm*, that got kicked out of Paramount Pictures." And so, he was very interested in that, because I had established a very high level of credibility with him, at Columbia, and made ... I think I contributed a lot to the success of *Close Encounters*, with the mothership, and the UFOs, and all that stuff.

Doug: So I got this deal to make *Brainstorm* at MGM. And when I got to this meeting at MGM about the process, the Showscan process, they said, "Doug, it's just too hard. Getting theaters to convert to a different kind of projector or a different kind of screen; it's just never going to happen. So you've just got to give up on that. We just don't see it happening. And we're not going to do it. But whatever you want to do otherwise, let us know what it is." So I said, "Okay, I will find an alternative solution, which I think will be changing the aspect ratio, and changing from monophonic sound to stereo sound, and changing it from 35-mm to 70-mm.

Chris: Okay.

Doug: It's going to be a variable aspect ratio movie, but no frame rate stuff." That's the way *Brainstorm* was made. And it's been a huge disappointment to me that it could have been a transformational movie for the movie industry, to show how

high frame rates could really have created a new sense of immersion and spectacle.

Doug: So that's kind of a long story but, anyhow, that's the story behind that.

Chris: Well, I think it was really an amazing film. I know, obviously, that film had a lot of history and struggles in a lot of ways.

Doug: Yeah.

Chris: But I still love it. I still love that film.

Doug: That's great.

Chris: And I think the performances were really great. I think the idea ... I mean, really, you were creating a film about VR-

Doug: Yes-

Chris: ... long before any of that was around.

Doug: Yeah.

Chris: And I think it was really kind of a thing that, when I was a kid, I think the first time I actually saw it was on VHS tape!

Doug: Oh man!

Chris: So it completely ruined everything-

Doug: Oh yeah-

Chris: ... but I still love it. And then, I saw it more recently, obviously, in a higher resolution, and all of that, and it really just had that feeling of, when you go into that world, it may not be 60-frames-a-second, but you definitely see the resolution, you see the bigger picture. And you shot everything in these beautiful fish-eye lenses. I don't know what kind of fish-eye lenses those were?

Doug: Well, that was very similar to what Kubrick had done in *2001*-

Chris: Right, okay.

Doug: ... with fish-eye lenses. That's really part of the equation.

Chris: Because fish-eye lenses always tend to look so cheap sometimes, but they didn't. They're beautiful fish-eye lenses, like, really immersive, and they look fantastic. So it was a really great thing, for sure.

Doug: Thank you. Yeah.

Construct and Magi

Chris: Now, I don't want to get too much into ... Because I know we're running out of time, and I want to be worried about your time as well.

Chris: When you came up to us, basically, we had this one short that we had created, when I was working with Kevin Margo, we had created a teaser for “Construct,” and it was one minute. And you'd found out through NVIDIA, that we'd done it, basically, 30 second video cards, and the rendering was very quick because of that. And so, somehow, we convinced NVIDIA to loan us a bunch of computers, and to render the entire thing at 60-frames-a-second, each eye, at 4K. So when we added up the number of pixels, how many more pixels we had to render compared to the original version, it was forty times more.

Chris: But when I saw it on that screen, I was really, really blown away. And you're still showing that, am I correct?

Doug: Oh yeah. It's right here in this little theater behind me.

Chris: That's really awesome.

Doug: We show it quite often, and people are blown away every time.

Chris: Yeah.

Doug: Because it has this effect of taking out what is really animation, or performance capture, and making it look like it's absolutely real.

Chris: Yeah.

Doug: They're real characters, and they're fully dimensional, and they're in the room with you. It's a completely different immersive experience.

Chris: Yes.

Doug: So working with you guys on that ... See, my take on that, and one of my objectives in doing that little experiment with you, I had a couple of particular ideas about it. One of them was that we were going to up-res an existing movie that you had already made, it was all baked in, all the depth of field, all the lens

angles; all of it was baked into the movie. And I said, "Let's just take that as is. I don't want to change anything. I'm not going to ask you to change the convergence or anything. And just render it at 120 frames total, 4K."

Doug: And it was lucky that John Ison was there that day when we were at NAB. I don't know if he's still at NVIDIA, but they're-

Chris: He is, absolutely.

Doug: ... a real leader in this world of image manipulation and stuff. So they wanted to test this graphics, engine based, render farm, right?

Chris: Right.

Doug: So the idea that I was trying to pursue is to say, if you could take an existing animated film, and it's done, and all you need to do is to convert it to our process, which is nothing but machine time, no human time, no intervention by humans, fixing things or doing anything, take it exactly as it is and re-render it at a high frame rate, and it worked perfectly. And that was a really good idea, and it really succeeded, and the results are stunning.

Doug: And so that means that there's this whole market that we opened up at that time, that you could take any animated film, whether it's *Frozen*, or you name it, there's a million of really good animated films out there, and make them become much more powerful, and much more real, and much more compelling than they are in 2D, or at 24 frames.

Chris: Well, I learnt so much from it, because there were so many things that, you know, like, looking through every detail, because I remember specifically we were talking about the shutter angle and all of this stuff, and I remember what we were trying to do. So, for example, it was like, okay, so since the projector is going to project left eye then right eye, left eye, right eye, left eye, right eye, we temporally offset it by one-one-twentieth of a second so that whatever's being projected is temporally correct. We're not showing the same time at different times.

Doug: Right.

Chris: We're showing the right time at the right time.

Doug: Right. Right.

Chris: And the other thing that was also interesting is the motion blur, which is something ... Again, we are used to seeing motion blur to seem cinematic, right? But we did our motion blur physically correct as well, because what we did is, the motion blur was a full frame of motion blur. So a full 360. Like, the full exposure.

Doug: Oh really? Okay.

Chris: Yeah. So that, basically, it's one-one-twentieth of the time, so that it was as if the shutter was open for the whole time, and then the next shutter. So you're basically getting, as you said, the shutter is open the whole time; it's going left eye, right eye, left eye, right eye, but it's open the whole time.

Doug: Yeah. And that's okay.

Chris: Yeah. That's what made everything look so smooth.

Chris: But there was something interesting, was, I have been so used to not liking the 120-frame motion smoothing on TVs, when suddenly I see it this way, I was, like, "There's something we've been doing that's been wrong for so long," so it was really interesting to see that.

Doug: Yeah. Well, I've been at this thing for an awfully long time, Chris, and it's been very troubling to me that the movie industry has gone down this path of 24-frames with double shutters, and blur, and stuff, for so many years, and it's become so habitual that it just doesn't want to change, and doesn't want to learn anything, it doesn't want to do anything differently.

Doug: It's been a really hard path for me. I mean, I live with a grim world of being rejected and misunderstood, and yet everyone who comes here and sees “Construct,” or “UFOTOG,” or anything else, they're just utterly blown away. They've never seen anything like it, and they say, "Wow! That looks like a movie." It tells a story, it's emotional; everything you want it to be is there. But it doesn't have any bad artifacts, or blurring, or nasty stuff, and you can have tremendous high action. It's been a long haul for me. I'm still plugging away at it, even in spite of the fact that *Gemini Man* kind of distorted everyone's perception of what it could or should be.

Doug: Because, I, actually ... And this is another little story I could tell you about working with, I guess it's Paramount that did *Gemini Man*. And I had to tell them, I said, "Listen, you guys. I know Ang Lee has basically derived what he's done based on my work. He's visited my studio eight times. He's had his cinematographers here, his editors here, his post-production team; everybody's come to this studio to see the thing right behind me, and they get blown away, and they love it. And so, I feel that I have been fair and honest with you guys, and I have patents on this. And if you violate my patents on the release of this movie, there could be a problem. And I don't know what the problem is, but it could be a problem."

Doug: So we finally came to an agreement that I would take a screen credit on the movie, with me knowing full well that they probably wouldn't do it right. Which they didn't. They still didn't understand it. And this has been a lesson to me, that even though you can get screen credit on a big movie like that, it doesn't make any difference. And it doesn't change the fact that in today's movie industry ... You see, you're in the animation industry-

Chris: Yeah-

Doug: ... and so, when you come, like I did, and like you have, you come at a movie one frame at a time, and then you animate it, that's where you understand what motion is all about and how movies work and everything. And then it starts becoming more and more sophisticated, with really cool performance capture, and smoothing, and all the other things you can do to make movie magic. And all the rendering; amazing things you can do to make these characters look totally real, which is mind-boggling to me.

Doug: So we're in this age where very few professional filmmakers, or exhibitors, or studio heads, or directors, or cinematographers, understand how movies work. They simply don't know. If you go to Chris Nolan or someone, and say, "Do you know that your movie's being shown ... every frame is being shown five times?" He probably doesn't know that. A really nice guy, and very astute. But most people don't understand how movies work, and they don't understand that this transition from celluloid to digital has brought with it some tricky problems that are easy to solve, I mean they're brainlessly easy to solve. The Magi process is so elegantly simple to do, and so inexpensive to do.

Doug: And one of the things I wanted to ask you about, that maybe you could comment on here, which is when you get into this world which we're all in, in the movie industry, of computer-generated content, which means that there is a cost associated with every render of every frame.

Chris: Absolutely-

Doug: And the non-initiated person might look at, "Well, you mean ... I just did this movie, it's a 24-frame-per-second, 2K render, and it's going to take up our entire render farm for "X" months to do this." And I'm saying, "Why don't you do it at 120-frames?" And they say, "Well, that's ... Whatever number you came with is, how many pixels; 40 times more data." And they say, "Well, no way, we can't afford that. There's no way we could do that."

Doug: I was on the set of *The Lion King* recently, when John and .. They were all dealing with rendering hair of the lion, you know? And it was completely clogging up the entire Disney render farm. And they said, "Well, we can't do more frames. This would just be impossible, completely impossible. Or 4K, that would be impossible as well." So I'm saying, "Well, okay, maybe you think it's impossible. But I think where the money goes is in the human talent, and the human effort, and the human design, and the human animation, and only part of the money goes into the render." So maybe you have some comments on what that ratio is?

Chris: Okay. So there are ways you can do this. You are going to have to pay some way or another, right? And computer time is technically cheaper than artist time, for sure. But artist time is also expensive when the artist is waiting for renders.

Doug: Yes.

Chris: So that's kind of an issue. But you can solve that by doing your rendering on the cloud. Because on the cloud, you just use more computers and less time, so then the artist is not necessarily waiting for frames. There's also a lot of data that has to be processed, that becomes a little bit more expensive as well. I believe that it is possible to do that 120-frames-a-second. I do believe that there's ideas to make that happen that I think are fundamentally right.

Chris: But honestly speaking, and we only have a few minutes unfortunately, but the other thing that is, like ... People are not necessarily going to go to theaters that much, in fact, right now, I can't really go to a movie.

Doug: No, right. Right.

Chris: Right?

Doug: Right.

Chris: So now what we have to do is, we've got to rely on our TVs to be our movie theaters. And our TVs are fairly capable of creating some pretty beautiful images.

Doug: They're pretty good. Pretty amazing.

Chris: They're pretty good.

Doug: Yeah.

Chris: And you can do 120 Hertz, at least, on a TV, technically speaking.

Doug: Yes, you can.

Chris: So I'm actually curious, do you think that maybe that's the way we can do it?

Doug: I think this is really fundamentally salient to what I'm working on right now, because you want to make a movie that's compatible with theaters and televisions. And we're in this weird moment because of the virus and everything, and everybody's at home, streaming every movie they can possibly see. And television is really quite extraordinarily good, particularly when it's 4K, and if we can get the industry to understand that this shuttering issue is vitally important to up-resing or interpolating, you've got to be very careful that you don't ... You're not aware of that; you can't just take any 24-frame movie and make it 120 or 240, it will look like a soap opera. That can be fixed, that's all fixable. So if we can get over that hurdle, I think we can make big inroads into the home TV business.

Doug: There's another thing happening, which is if you look at these monster TVs that are being built for 8K television-

Chris: Yep-

Doug: ... are you ready for your 8K render, Chris?

Chris: Nope. You're just adding four times more render, just, better.

Doug: Exactly. So anyway these are humongous TVs, and the bandwidth to enable 8K is going to be a lot. And so, I think, if you'd say, "Well, let's take this bandwidth and let's just use it differently to do two 4K, 60-frame image streams, instead of one 8K, 60 image stream." It's about the same amount of data. And we're working with a company that's doing some really amazing compression algorithms.

Chris: Oh nice.

Doug: You can get the data rate down, and it still looks absolutely unpreferred.

Chris: Yeah, I think that's going to be key, is compression.

Doug: Yeah. It's going to be compression, yeah.

Doug: So I think there's a lot of reasons for optimism. And I'm not against television at all, I think it's an amazing thing. But one thing you have to also understand when you talk about frame rates or immersion, or making what I call "cinematic spectacle," is you want a very wide field of view, like Cinerama was, or like D150 was, or like Todd-AO was. So a very wide field of view, which means if you have an 8K or a 4K TV, and you make a movie that's really designed to optimize that, you really should sit a little closer to your TV.

Chris: Right!

Doug: You know? And be in the movie. It'll be much more powerful. And one of the things they've found in SMPTE, S-M-P-T-E studies, is that when people buy a 4K TV, which is bigger than their 2K TV, they sit further away. They just naturally gravitate to just seeing a movie that's far enough away from them so they don't get taken over by it.

Chris: Right. Interesting.

Doug: I don't know what to do with that. But I think that the home theater is going to start transforming and be really pretty good. And we know we can do our Magi process, digitally, and transmit with reasonable bandwidth.

Chris: That's interesting. I think that's great. That's great.

Chris: Well, I could keep talking to you for a while, and I would, but unfortunately I want to make sure I have ... I have another meeting I have to go to, and I just ... It's been a fascinating talk. I definitely want to share my Brainstorm podcast with you when it comes out, because I think you'd love it.

Doug: Great. Thank you.

Chris: We had a great time doing that.

Chris: And it was really an honor for me to be able to work with you on this Construct thing, and make that happen. I know Kevin had an amazing time doing it as well. Kevin is the director, obviously. So it was really kind of a cool experience.

Doug: It was really fantastic. Yeah, I'm really happy that I worked out so well.

Doug: Okay Chris, thank you, too.