The Racial Character of Computer Graphics Research

Theodore Kim, Alexa Schor, Julian Posada, Alka V. Menon
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Good morning everybody. Today I'm going to talk about computer graphics research, the algorithms used to make CGI effects in movies and 3D video games. By research I mean the academic journals and conferences that publish and disseminate these algorithms.

We are going to ask two very simple questions.

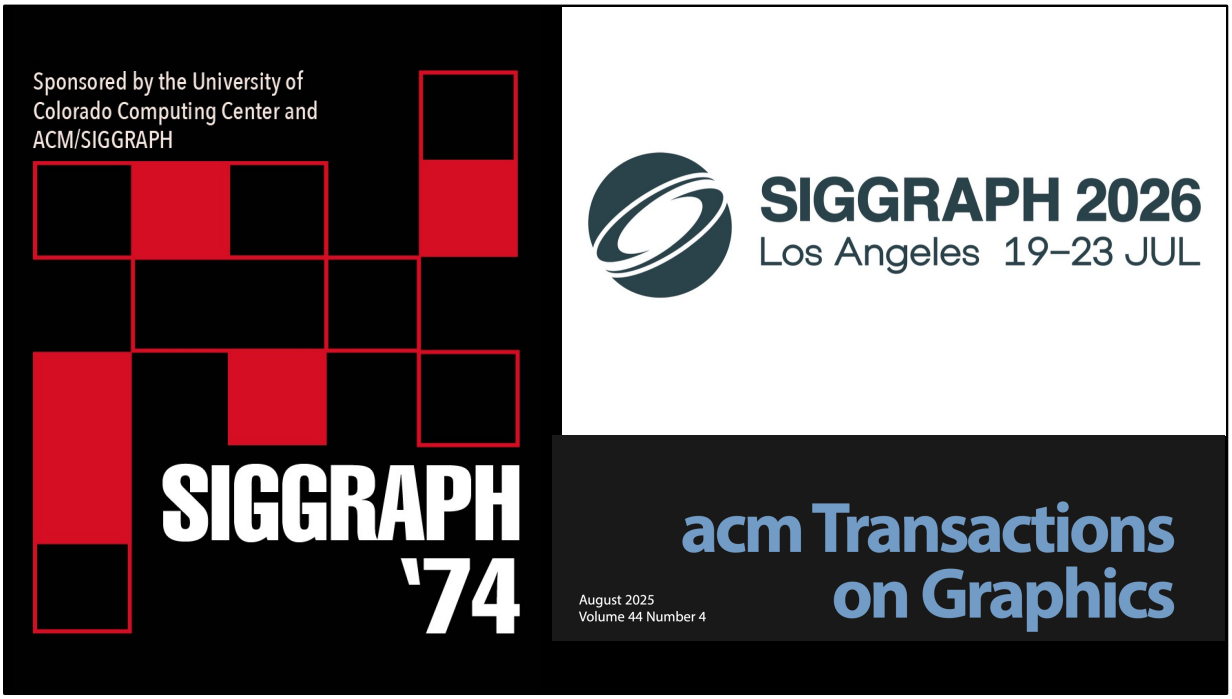
What does “skin” mean in computer graphics?

First: What does the word “skin” mean in computer graphics research?

What does “hair” mean in computer graphics?

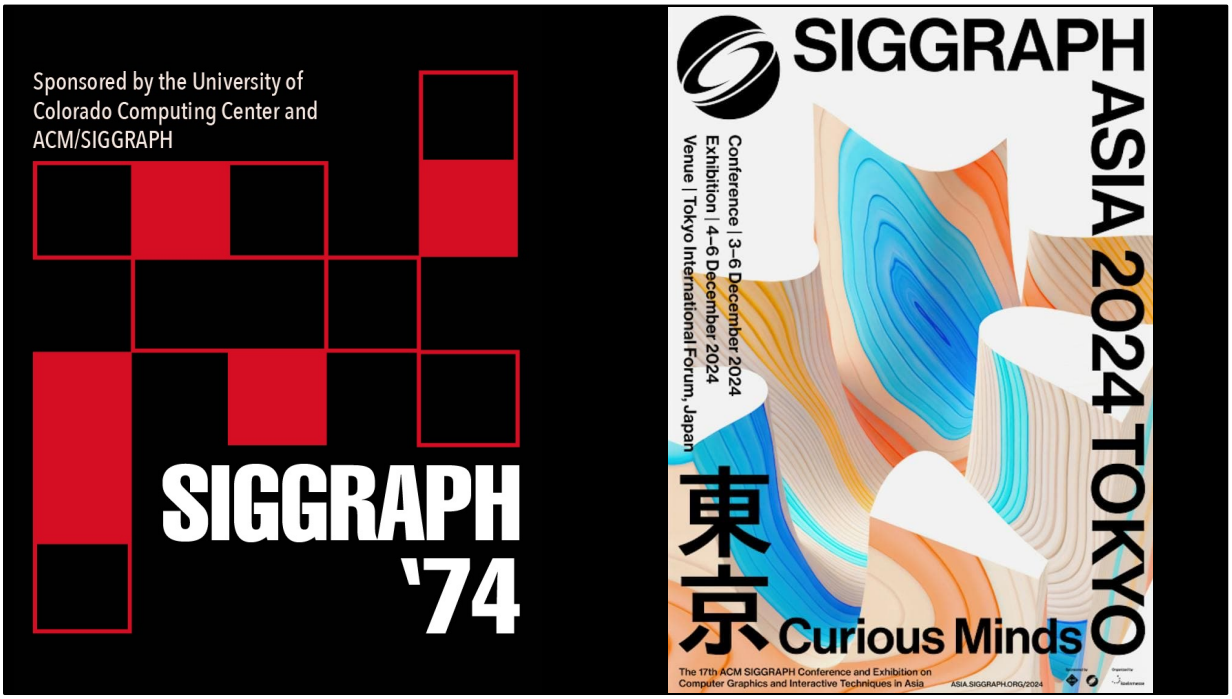
Second: what does the word“hair” mean in computer graphics research?

Researching being done by people like me. I don’t usually publish here at FAccT, I’ve been publishing in computer graphics for over 20 years.



Our flagship conference is SIGGRAPH, the Special Interest Group on Graphics and our flagship journal is ACM Transactions on Graphics (“TOG”).

In terms of conference attendance and journal impact factor, no other venue is even close. If you want to understand the graphics research community, you should look there.

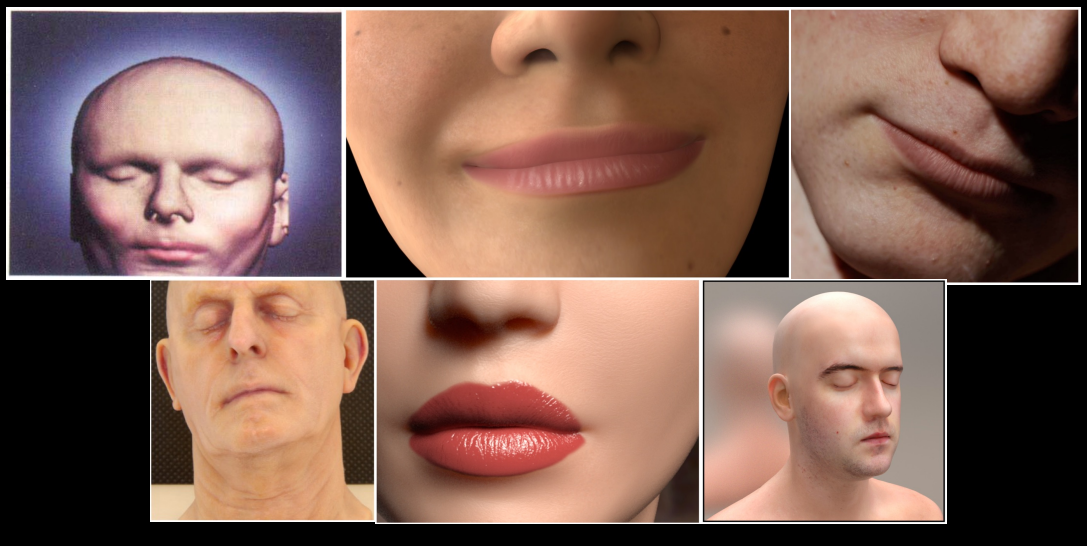


So we did. We got the raw text of every article ever published at this journal and conference through 2024.

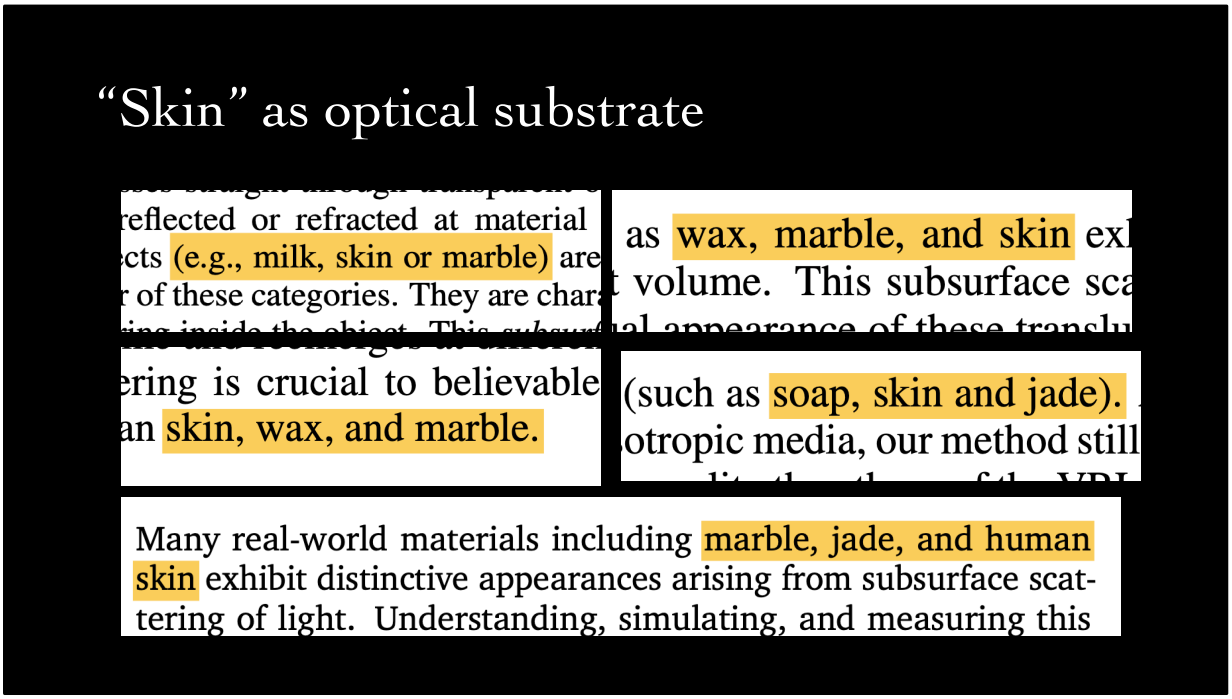
Search for “skin”

Here’s what we saw when looked up the word “skin”.

“Skin” as optical substrate

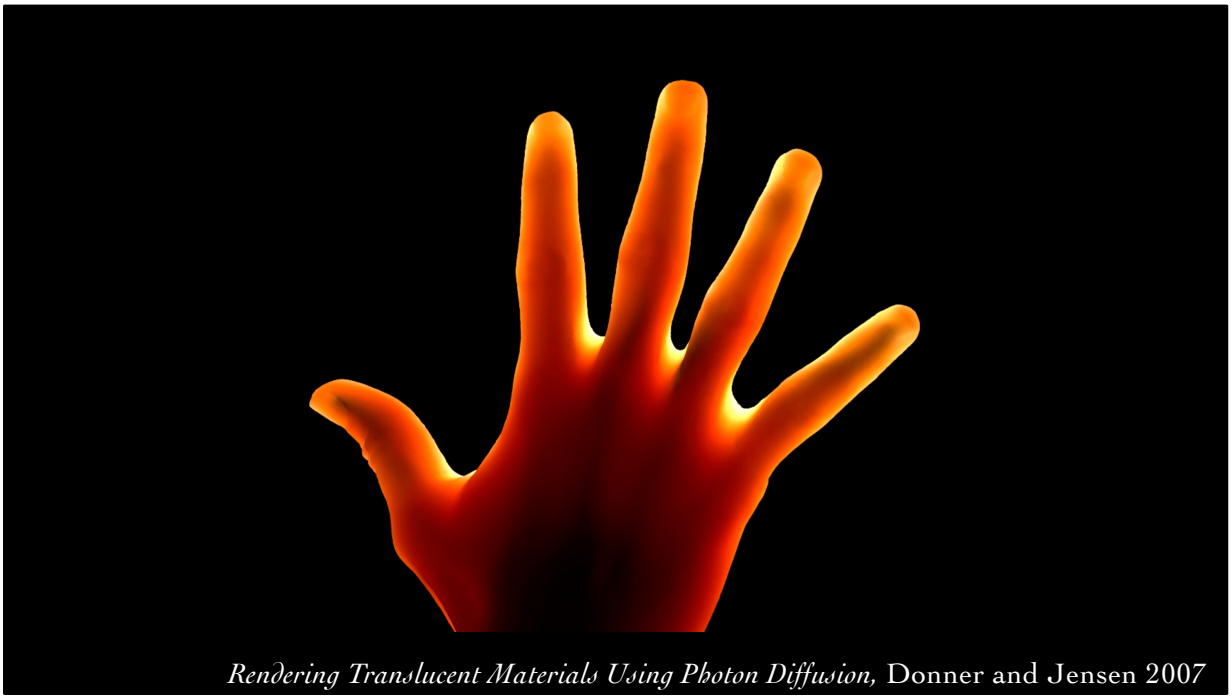


Some papers investigate “skin” on the most basic physical and optical level. These all investigate white skin.



In these papers, skin is imagined as a "pale translucent material" like milk, marble, wax, and soap.

The language is consistent across decades and research groups

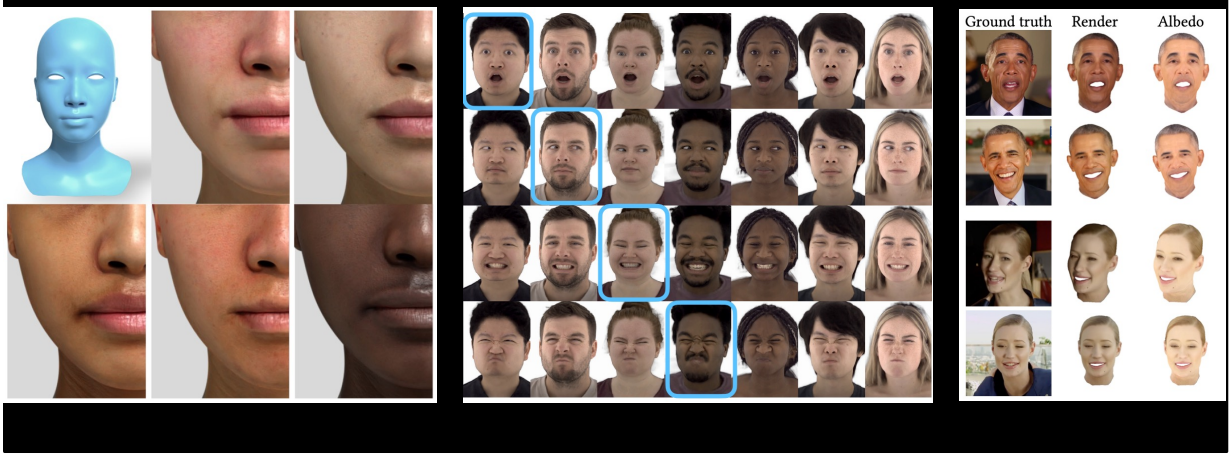


They all simulate subsurface scattering: how light spreads out in a highly diffusive medium. How light makes white skin glow.

Black skin never appears in these papers. Skin like that appeared in last year's movie *Sinners*.

There are no papers that analogize “chocolate, onyx, and skin”. Nobody has written that paper.

“Skin” as a full human face

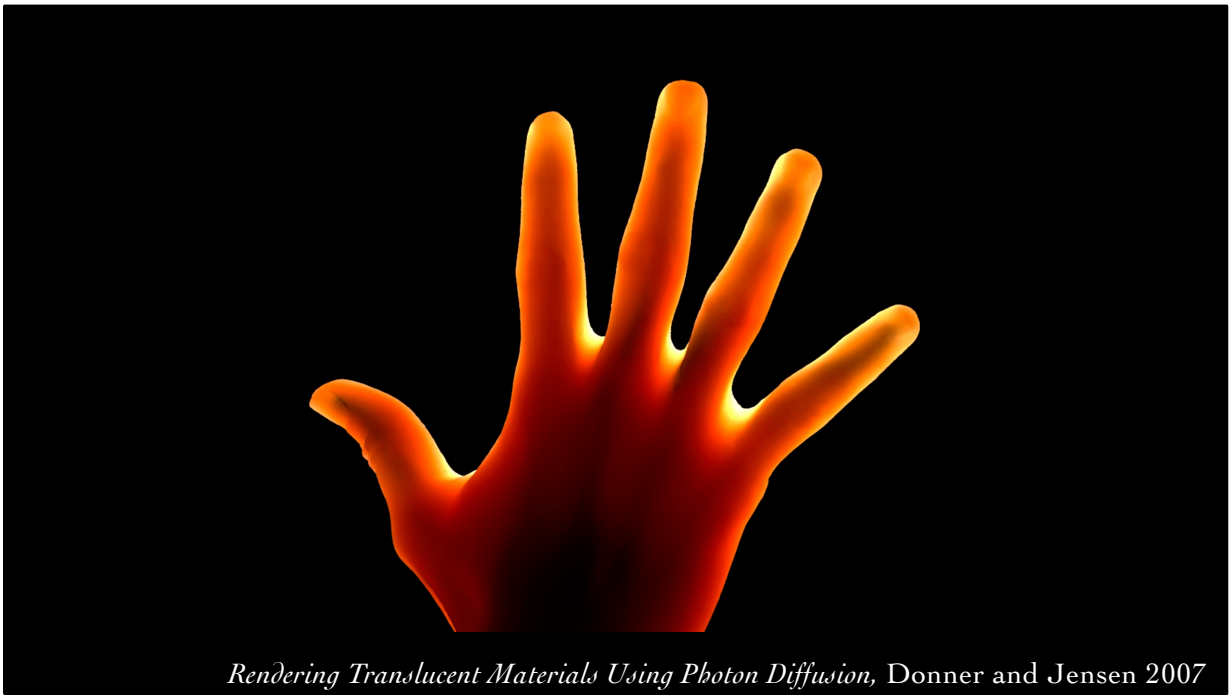


We found other kinds of “skin” papers in graphics, including what we called “human face” papers. These are avatar creation papers like for Mark Zuckerberg’s Metaverse.

These papers primarily feature white skin, but do have Black skin examples. Those Black skin renders all use the white skin algorithms.

The lighting capture setups used are clearly calibrated for white skin.

Here are a few examples from the papers, and what is going on? Are these people locked in a basement?



Rendering Translucent Materials Using Photon Diffusion, Donner and Jensen 2007

It is known among cinematographers that “skin glow” is not as important a visual feature for Black skin.

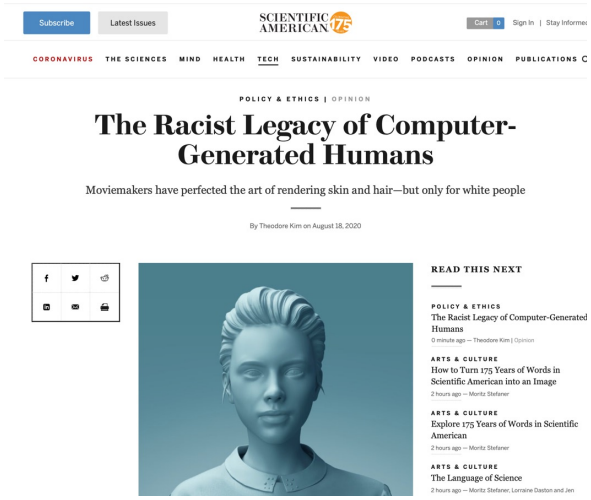
Instead, it is known to be the “shine”. Look at the highlights on Wunmi Mosaku and Delroy Lindo’s forehead and cheekbones.

Those highlights have been deleted in the facial capture papers.

This is the aesthetics of white skin applied to Black skin.

Even these underwhelming Black examples only started appearing around 2020,

After the murder of George Floyd. This was after significant advocacy by critics within the graphics community.



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The Racist Legacy of Computer-Generated Humans

Moviemakers have perfected the art of rendering skin and hair—but only for white people

By Theodore Kim on August 18, 2020

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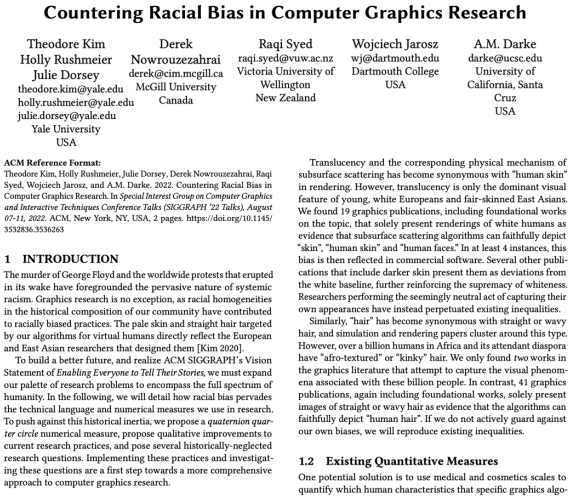

Countering Racial Bias in Computer Graphics Research

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1 INTRODUCTION

The murder of George Floyd and the worldwide protests that erupted in its wake have foregrounded the pervasive nature of systemic racism. Graphics research is no exception, as racial homogeneities in the historical composition of our community have contributed to racially biased practices. The pale skin and straight hair targeted by our algorithms for virtual humans directly reflect the European and East Asian researchers that designed them [Kim 2020].

To build a better future, and realize ACM SIGGRAPH's Vision Statement of *Enabling Everyone to Tell Their Stories*, we must expand our palette of research problems to encompass the full spectrum of humanity. In the following, we will detail how racial bias pervades the technical language and numerical measures we use in research. To push against this historical inertia, we propose a *quaternion quarter circle* numerical measure, propose qualitative improvements to current research practices, and pose several historically-neglected research questions. Implementing these practices and investigating these questions are a first step towards a more comprehensive approach to computer graphics research.

Translucency and the corresponding physical mechanism of subsurface scattering has become synonymous with "human skin" in rendering. However, translucency is only the dominant visual feature of young, white Europeans and fair-skinned East Asians. We found 19 graphics publications, including foundational works on the topic, that solely present renderings of white humans as evidence that subsurface scattering algorithms can faithfully depict "skin", "human skin" and "human faces." In at least 4 instances, this bias is then reflected in commercial software. Several other publications that include darker skin present them as deviations from the white baseline, further reinforcing the supremacy of whiteness. Researchers performing the seemingly neutral act of capturing their own appearances have instead perpetuated existing inequalities.

Similarly, "hair" has become synonymous with straight or wavy hair, and simulation and rendering papers cluster around this type. However, over a billion humans in Africa and its attendant diaspora have "afro-textured" or "kinky" hair. We only found *two* works in the graphics literature that attempt to capture the visual phenomena associated with these billion people. In contrast, 41 graphics publications, again including foundational works, solely present images of straight or wavy hair as evidence that the algorithms can faithfully depict "human hair". If we do not actively guard against our own biases, we will reproduce existing inequalities.

1.2 Existing Quantitative Measures

One potential solution is to use medical and cosmetics scales to quantify which human characteristics that specific graphics algo-

And by critics, I mean me and my colleagues

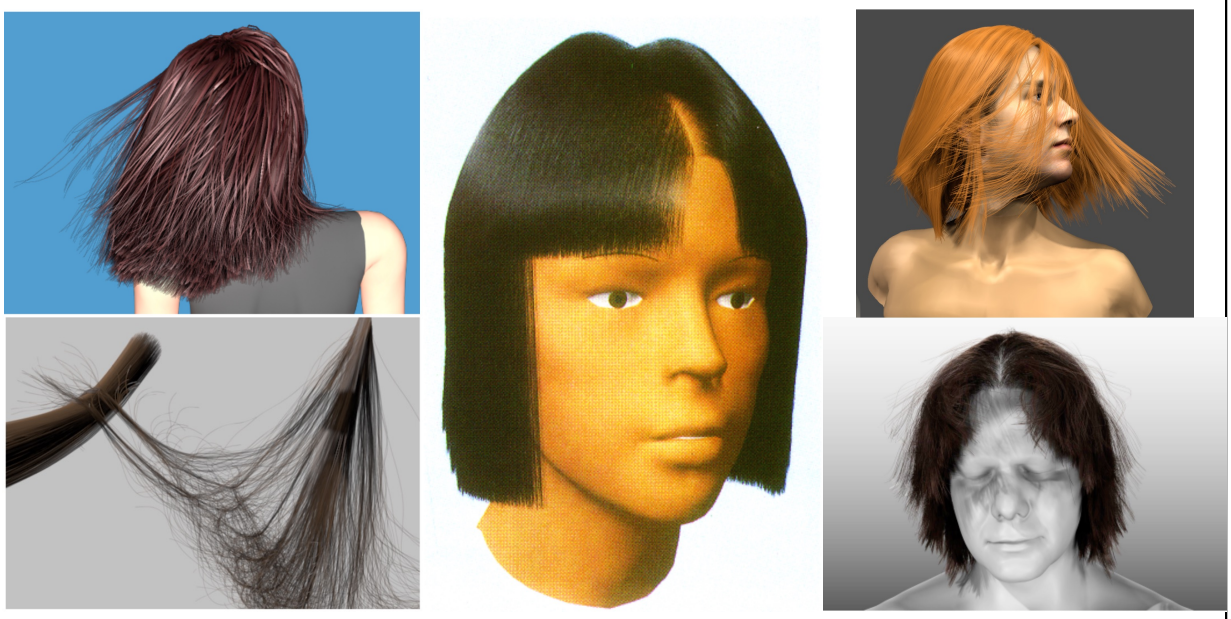
“Skin” means “white skin” in computer graphics

To summarize, in graphics, “skin” means white skin.

Papers have only grudgingly included crappy examples of Black skin since 2020.

Search for “hair”

Let’s move on to “hair”. We did a search over all SIGGRAPH and TOG papers for “hair”.



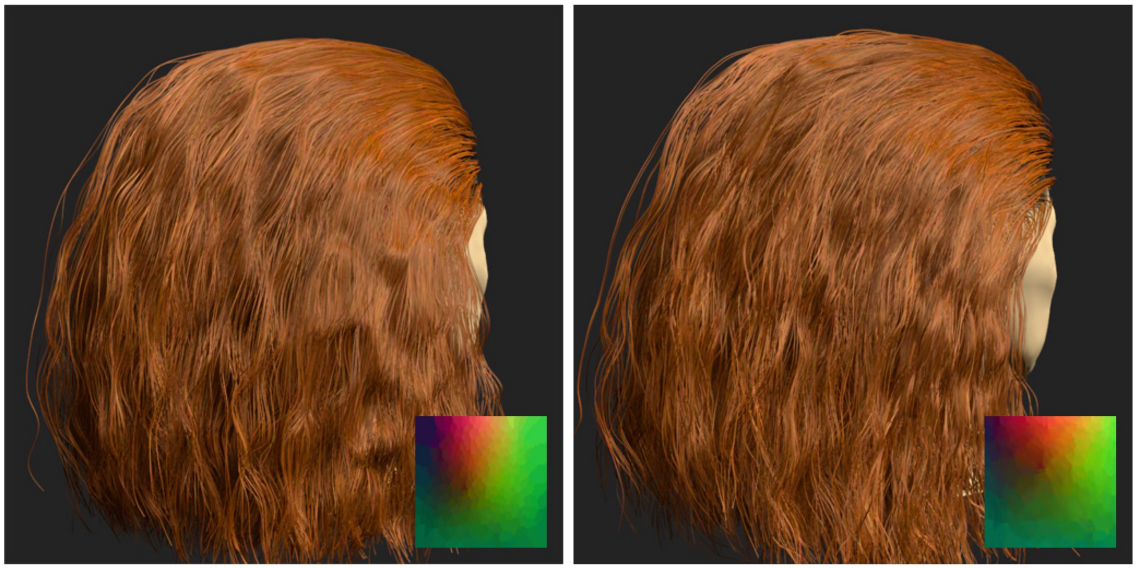
Hair almost always means straight hair. Like, REALLY straight hair. Graphics papers on hair show straight hair, and often ONLY straight hair.

Significant *binarization*

Here we found *binarization*. Everything that is not straight hair got lumped into "curly." Everything from lightly wavy to highly coiled hair.

Figure 20. Curly ponytail.

Curly hair often means this. Slightly wavy hair. It's a proxy term for "not straight" hair.



(c) Curly

Here's another instance of curly hair

curly

Here's another one. Algorithms are evaluated on straight hair and curly hair, and if it works on both, authors say it works for all hair.

Algorithms are evaluated on straight hair and curly hair, and if it works on both, authors say it works for all hair.

Again, after me and my colleagues publicly criticized this practice after the murder of George Floyd.

Sag-Free Initialization for Strand-Based Hybrid Hair Simulation, Hsu et al. 2023

Some curlier examples started appearing in 2023.

The curly hair often looks awful, and gets tacked on at the end of the paper.

Curly-Cue: Geometric Methods for Highly Coiled Hair

HAOMIAO WU* and ALVIN SHI*, Yale University, USA
A.M. DARKE, University of California, Santa Cruz, USA
THEODORE KIM, Yale University, USA

Fig. 1. 234K highly coiled hairs generated by combining our *phase locking*, *period skipping*, and *switchback* methods. The head is modelled after *New York Times* bestselling author Carvell Wallace [Iguodala and Wallace 2019], and used with his permission.

The first SIGGRAPH paper that treated Black hair as a first class research problem was this one from 2024.

This was written by me and my colleagues.

“Hair” means “straight hair” in computer graphics

In graphics, “hair” means straight hair.

"Hair" means "straight hair"
in computer graphics

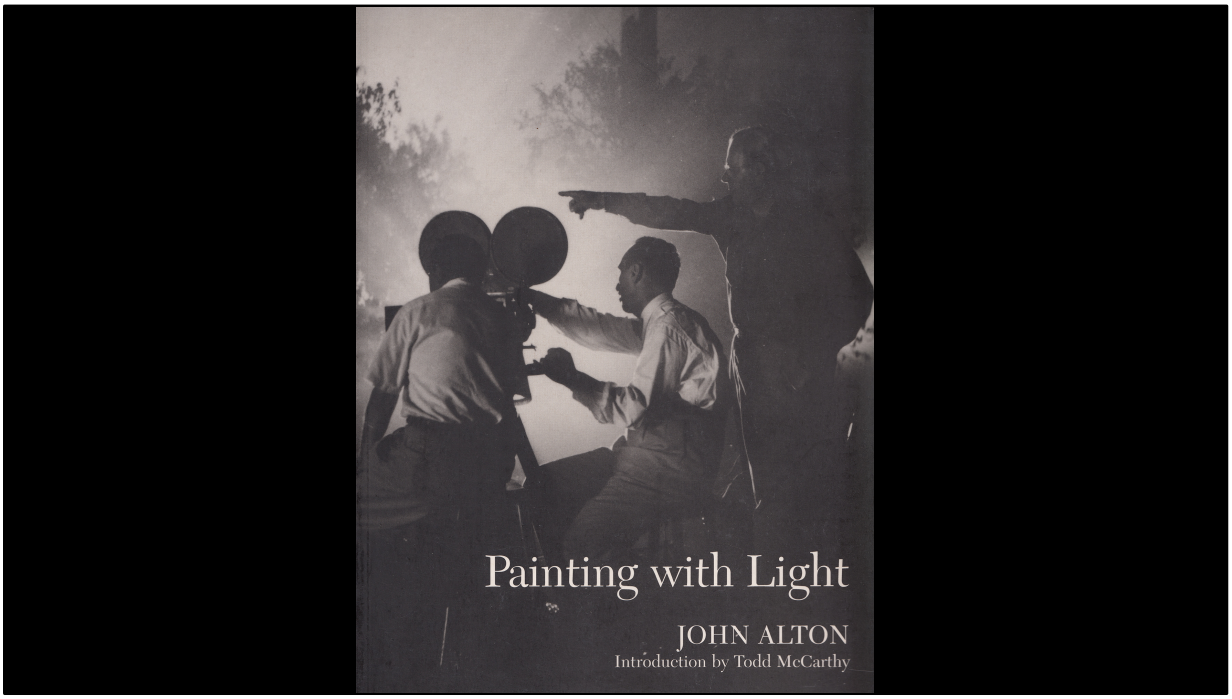
After 2020:
… plus one crappy Black example

Starting it 2020, it also meant "plus one crappy Black example."

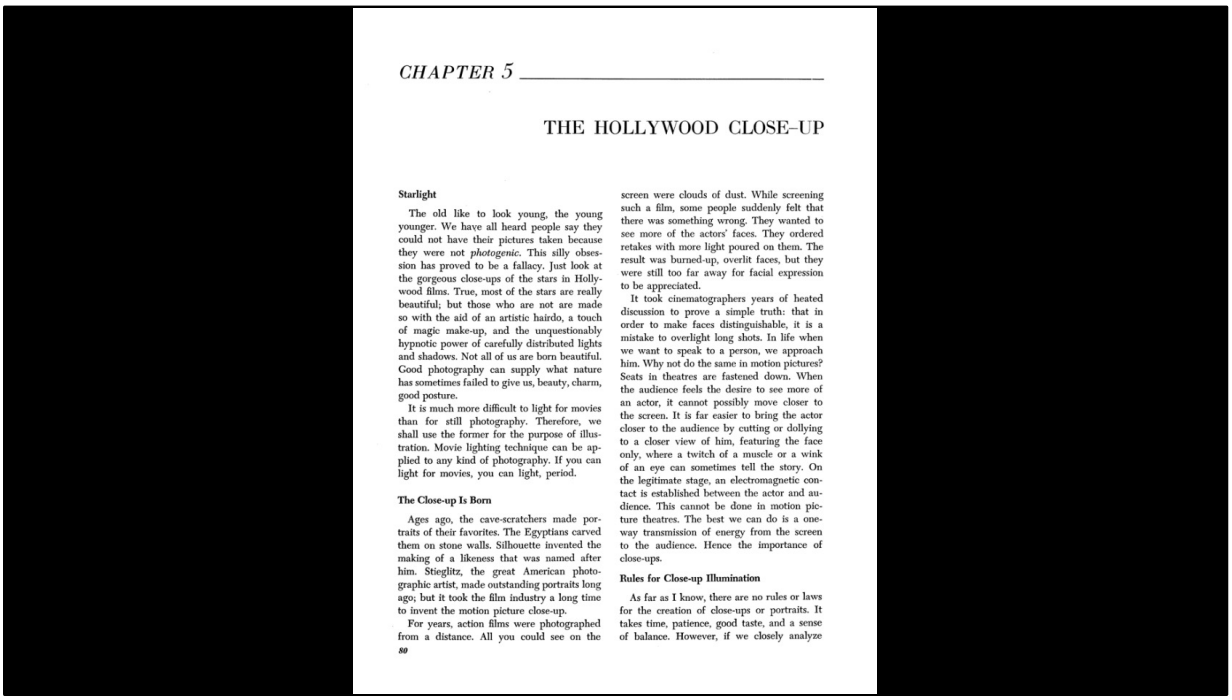
New Terminology

I will conclude with some new terminology.

Designing techniques for white skin and tacking a crappy example of Black skin at the end has been going on for a long time.



This is *Painting With Light*, a standard film lighting manual from 1949 written by cinematographer John Alton



CHAPTER 5

THE HOLLYWOOD CLOSE-UP

Starlight

The old like to look young, the young younger. We have all heard people say they could not have their pictures taken because they were not *photogenic*. This silly obsession has proved to be a fallacy. Just look at the gorgeous close-ups of the stars in Hollywood films. True, most of the stars are really beautiful; but those who are not are made so with the aid of an artistic hairdo, a touch of magic make-up, and the unquestionably hypnotic power of carefully distributed lights and shadows. Not all of us are born beautiful. Good photography can supply what nature has sometimes failed to give us, beauty, charm, good posture.

It is much more difficult to light for movies than for still photography. Therefore, we shall use the former for the purpose of illustration. Movie lighting technique can be applied to any kind of photography. If you can light for movies, you can light, period.

The Close-up Is Born

Ages ago, the cave-scratchers made portraits of their favorites. The Egyptians carved them on stone walls. Silhouette invented the making of a likeness that was named after him. Stieglitz, the great American photographic artist, made outstanding portraits long ago; but it took the film industry a long time to invent the motion picture close-up.

For years, action films were photographed from a distance. All you could see on the screen were clouds of dust. While screening such a film, some people suddenly felt that there was something wrong. They wanted to see more of the actors' faces. They ordered retakes with more light poured on them. The result was burned-up, overlit faces, but they were still too far away for facial expression to be appreciated.

It took cinematographers years of heated discussion to prove a simple truth: that in order to make faces distinguishable, it is a mistake to overlight long shots. In life when we want to speak to a person, we approach him. Why not do the same in motion pictures? Seats in theatres are fastened down. When the audience feels the desire to see more of an actor, it cannot possibly move closer to the screen. It is far easier to bring the actor closer to the audience by cutting or dollying to a closer view of him, featuring the face only, where a twitch of a muscle or a wink of an eye can sometimes tell the story. On the legitimate stage, an electromagnetic contact is established between the actor and audience. This cannot be done in motion picture theatres. The best we can do is a one-way transmission of energy from the screen to the audience. Hence the importance of close-ups.

Rules for Close-up Illumination

As far as I know, there are no rules or laws for the creation of close-ups or portraits. It takes time, patience, good taste, and a sense of balance. However, if we closely analyze

Chapter 5 talks about lighting a human face

Fig. 153 *Mary Meade*

By which he means a white face

Fig. 163 *Spanish Beauty, Mary Inclan*

a white face

Fig. 191 *Lynn Bari*

a white face

Fig. 204 *Leslie Brooks*

a white face

CLOSE-UPS OF COLORED PEOPLE

There is a widespread belief that close-ups of colored people have to be overlit. Nothing

Fig. 201 *Hattie McDaniels*

can be farther from the truth. Although their skin may be darker in texture, they do not require more light than a white person. As a rule, they make very interesting studies for portrait photography. By lighting them normally, we get a bronze-like skin texture, a tint that gives the close-up an unusual pictorial quality (Fig. 201).

It ends with one Black example, and says “Yeah, lighting Black skin is the same.”

As evidence of this, it includes a lit photo of Hattie McDaniel,

CLOSE–UPS OF COLORED PEOPLE

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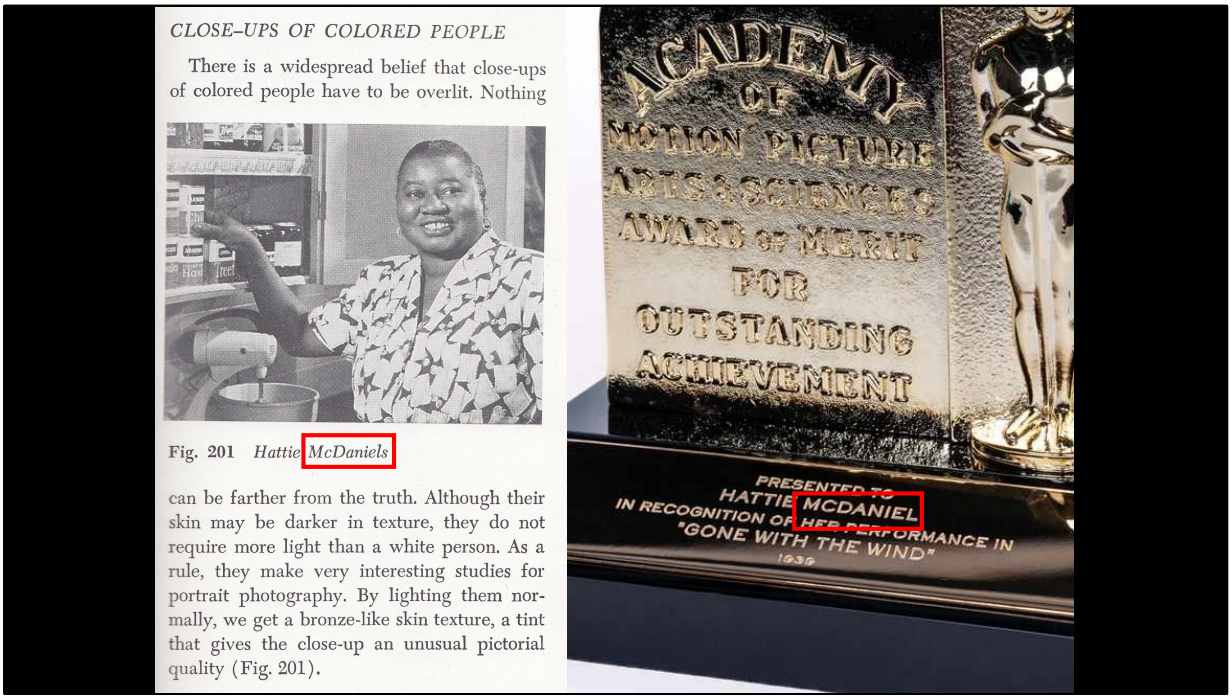
the first person of color to ever win an Academy Award.



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And he misspells her name.

Her name is McDaniel, not McDaniels. There is no trailing “s”.

McDaniels Methods

Thus, we propose the term McDaniels Method:

McDaniels Methods

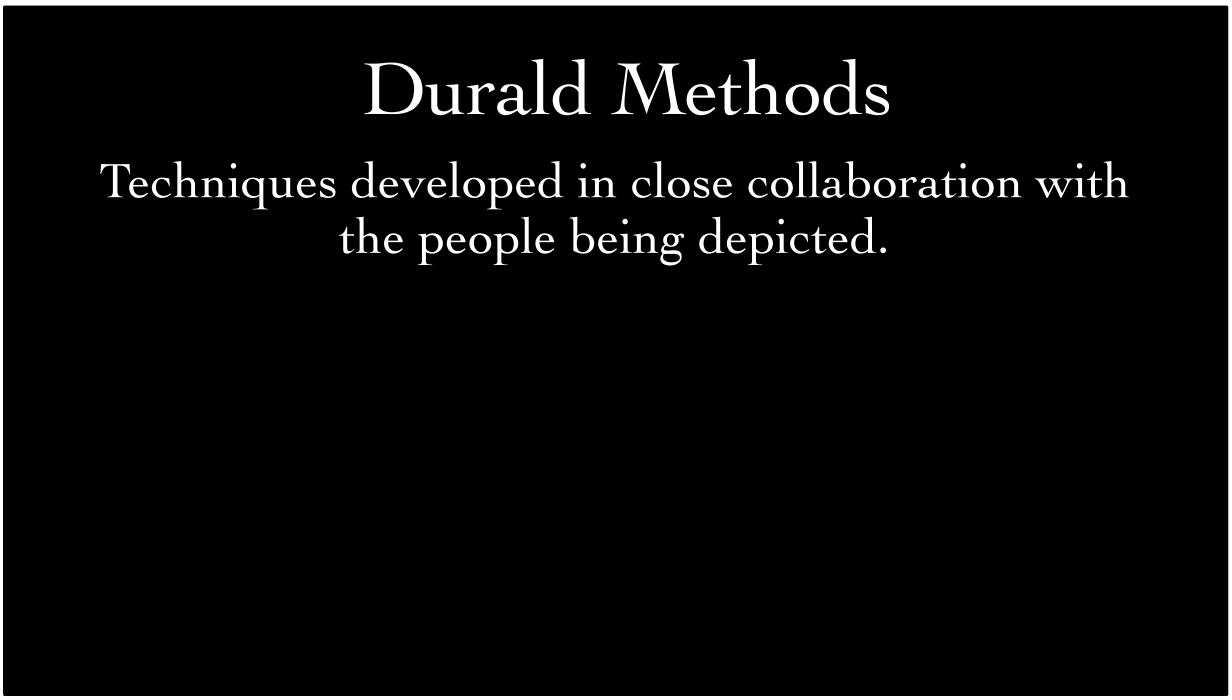
Techniques exhaustively validated on white skin and straight hair, that relegate all other forms of skin and hair to a small set of flawed and underwhelming examples.

techniques that are exhaustively validated on white skin and straight hair, and relegate all other forms of skin and hair to a small set of flawed and underwhelming examples

In computer graphics research, there are currently *lots* of McDaniels Methods.

Durald Methods

We also define the opposite, Durald Methods:



techniques that were co-created in close collaboration with the people being depicted.

Durald Method

Techniques developed in close collaboration with the people being depicted.

We name this after Autumn Durald Arkapaw, the first woman of color to ever win the best Cinematography Academy Award.

She won it this year. Just three months ago, for the movie Sinners.

Curly-Cue: Geometric Methods for Highly Coiled Hair

HAOMIAO WU* and ALVIN SHI*, Yale University, USA
A.M. DARKE, University of California, Santa Cruz, USA
THEODORE KIM, Yale University, USA

Fig. 1. 234K highly coiled hairs generated by combining our *phase locking*, *period skipping*, and *switchback* methods. The head is modelled after *New York Times* bestselling author Carvell Wallace [Iguodala and Wallace 2019], and used with his permission.

Our 2024 paper is a Durald Method.

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We wrote it in close collaboration with A.M. Darke, the top expert in the world on digital depictions of Black hair.

Is This a McDaniels Method or a Durald Method?

So, next time you see a computer graphics paper on skin or hair, ask yourself:

Fig. 201 *Hattie McDaniels*

Is This a McDaniels Method or a Durald Method?

is this a McDaniels Method

Fig. 201 *Hattie McDaniels*

Is This a McDaniels Method or a Durald Method?

Or a Durald Method?

If it's a McDaniels Method, call it out on its bullshit.

If it's Durald Method, share it with your friends.

That is my ask of you.

Fig. 201 *Hattie McDaniels*

Is This a McDaniels Method or a Durald Method?

Theodore Kim, Alexa Schor, Julian Posada, Alka V. Menon
Yale University
June 25, 2026

Thank you for listening to our talk.