EMOTION CHALLENGE

Building a New Photoreal Facial Performance Pipeline for Games

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EMOTION CHALLENGE

Building a New Photoreal
Facial Performance Pipeline for Games

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GOAL

A UNIFIED, ROBUST, SCALABLE PIPELINE FOR ACTOR LIKENESS ACQUISITION, CHARACTER ART, PERFORMANCE CAPTURE, AND CHARACTER ANIMATION

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GOAL

NUANCED EMOTIONAL PERFORMANCES

GOAL

NUANCED EMOTIONAL PERFORMANCES CONVEYED IN ENGINE


REC
A
TCG

PERFORMANCE-DRIVEN FACIAL ANIMATION

Recent Developments in the Motion Picture Industry
presented at DigiPro:

DigiPro2016
Digital Production Symposium

JASON SMITH: PERFORMANCE CAPTURE ON *WARCRAFT* AND THE ROLE OF OPTIMISM IN PRODUCTION

DigiPro2017
Digital Production Symposium

CORRAL ET AL.: CAPTURING A FACE

SPECIFIC CHALLENGES

Building a Facial Performance Pipeline for Games

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- working within model and rig limitations
- efficiently handling a large number of characters and a large volume of performances
- achieving consistency with pre-rendered cinematics
- supporting a wide range of animation pipelines and game engines*


ACTIVISION
VICARIOUS VISIONS
Toys For BOB
infinity ward
DESTINY
SKYLANDERS
beenox
HIGH MOON STUDIOS
CALL OF DUTY
ACTIVISION CENTRAL TECH
treyarch
SLEDGEHAMMER GAMES
RAVEN

ACTIVISION | BLIZZARD

King

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VICARIOUS VISIONS

Toys For BOB

infinity ward

DESTINY

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CALL OF DUTY

treyarch

SLEDGEHAMMER GAMES

RAVEN

BLIZZARD ENTERTAINMENT

WORLD OF WARCRAFT

STARCRAFT II

OVERWATCH

HEROES OF THE STORM

DIABLO III

HEARTHSTONE HEROES OF WARCRAFT

BUNGIE®

DESTINY®

ACTIVISION® | BLIZZARD®

King

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VICARIOUS VISIONS

Toys For BOB

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WORLD OF WARCRAFT

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HEARTHSTONE HEROES OF WARCRAFT

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BUILDING ON EXISTING TECH AND INTEGRATING NEW RESEARCH

THE EMOTION CHALLENGE

EMOTION CHALLENGE: GOALS

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TECHNOLOGICAL DEVELOPMENT

- analyze and document tech; assess for production
- consolidate character pipeline
- devise and implement new tech to replace or augment
- stay as high-resolution as possible throughout the pipeline, for best quality when targeting assets at different levels of detail
- support animation changes, but do not require polish

EMOTION CHALLENGE: GOALS

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CREATIVE TARGET

- capture and convey a genuine emotional performance using a pipeline viable for game development
- take on subtle emotions, which are more difficult
- demonstrate good results without animator polish

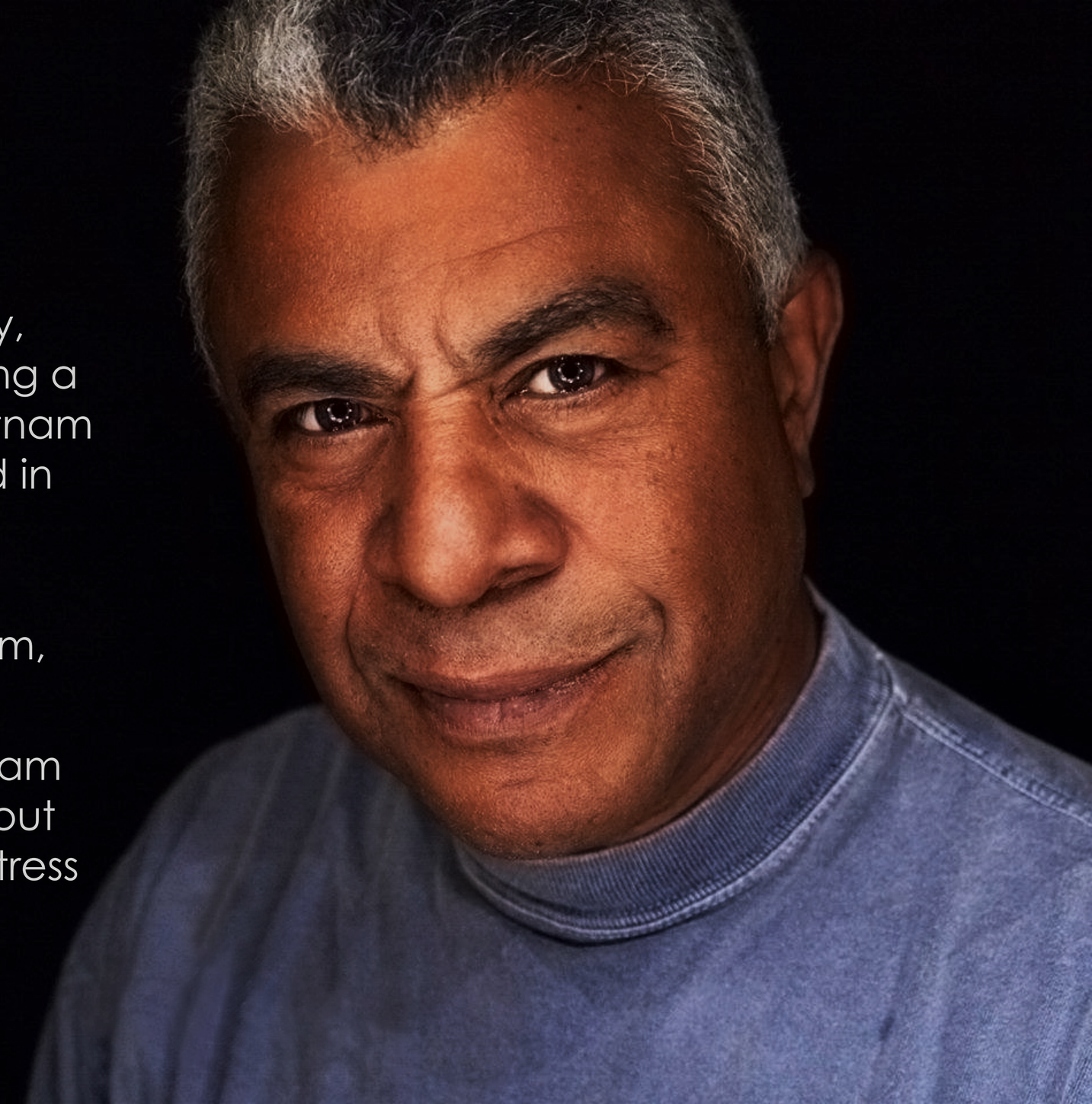
TALENT

Tucker Smallwood

Tucker served in the U.S. Army Infantry, Airborne from 1967-1970, commanding a Mobile Advisory Team during the Vietnam War where he was severely wounded in action.

After recovering from his injuries, he became an actor on Broadway, in film, and on television.

He also wrote a book about his Vietnam experiences, and speaks publicly about his experiences with Post-Traumatic Stress Disorder.



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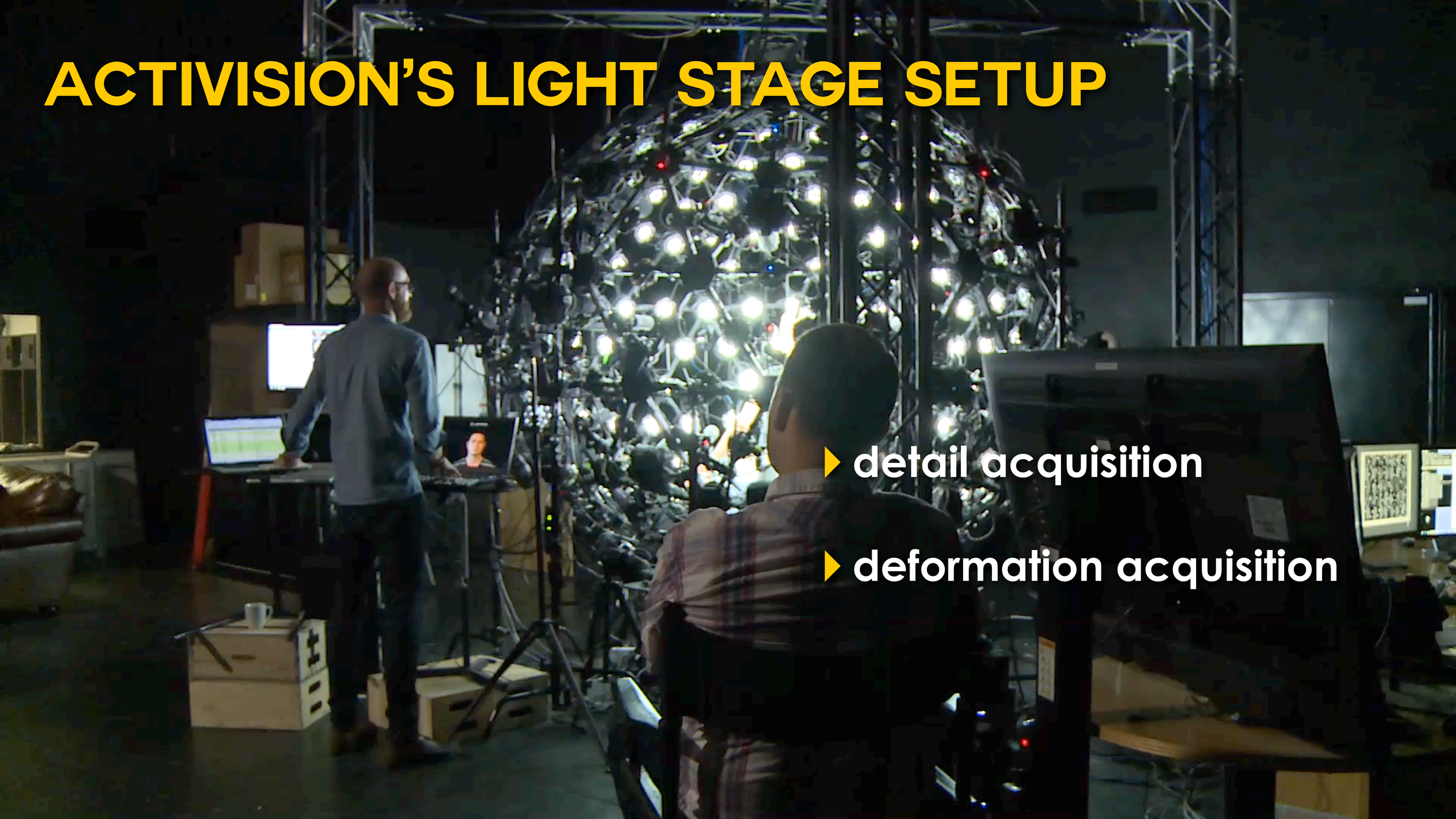
LIKENESS ACQUISITION

CAPTURING APPEARANCE FOR REPRODUCTION IN-GAME

ACTIVISION'S LIGHT STAGE SETUP



- detail acquisition
- deformation acquisition

ACTIVISION'S LIGHT STAGE SETUP

ACTIVISION CENTRAL TECH

Detail Acquisition

MA ET AL. RAPID ACQUISITION OF SPECULAR AND DIFFUSE NORMAL MAPS FROM POLARIZED SPHERICAL GRADIENT ILLUMINATION. EGSR 2007.

WILSON ET AL. TEMPORAL UPSAMPLING OF PERFORMANCE GEOMETRY USING PHOTOMETRIC ALIGNMENT. ACM TOG 2010.

GHOSH ET AL. MULTIVIEW FACE CAPTURE USING POLARIZED SPHERICAL GRADIENT ILLUMINATION. SIGGRAPH ASIA 2011.

FYFFE ET AL. COMPREHENSIVE FACIAL PERFORMANCE CAPTURE. EUROGRAPHICS 2011.

- 16 DSLRs

ACTIVISION'S LIGHT STAGE SETUP

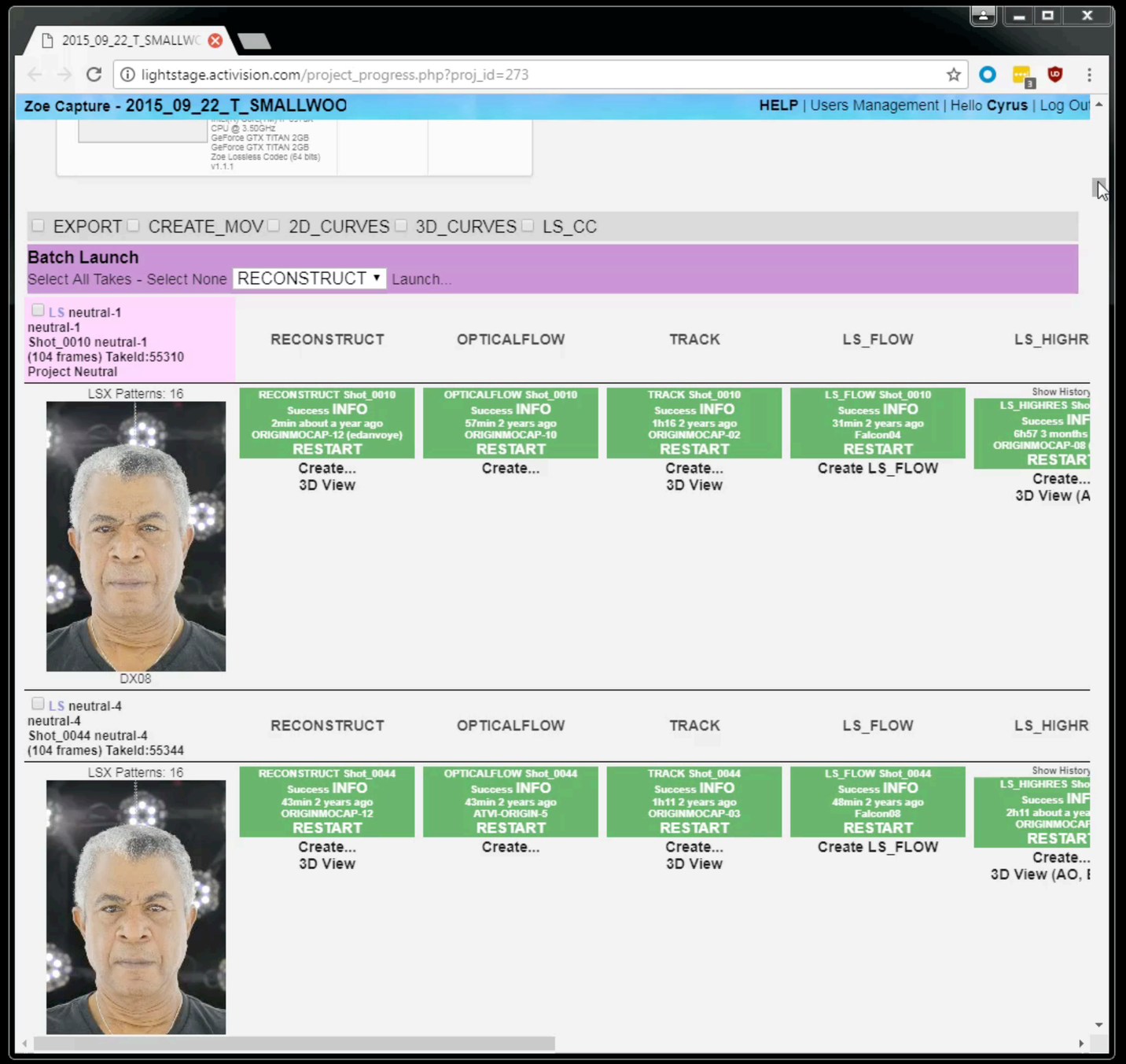
ACTIVISION CENTRAL TECH

Deformation Acquisition

MA ET AL. SEMANTICALLY-AWARE BLENDSHAPE RIGS FROM FACIAL PERFORMANCE MEASUREMENTS. SIGGRAPH ASIA 2016.

- 16 DSLRs
- 35 machine vision cameras: grayscale 2k x 2k @ 70fps

POSES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Zoe Capture - 2015_09_22_T_SMALLWOO
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POSES

ACTIVISION CENTRAL TECH

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Zoe Capture - 2015_09_22_T_SMALLWOOD Take Revie HELP | Users Management | Hello **Cyrus** | Log Out

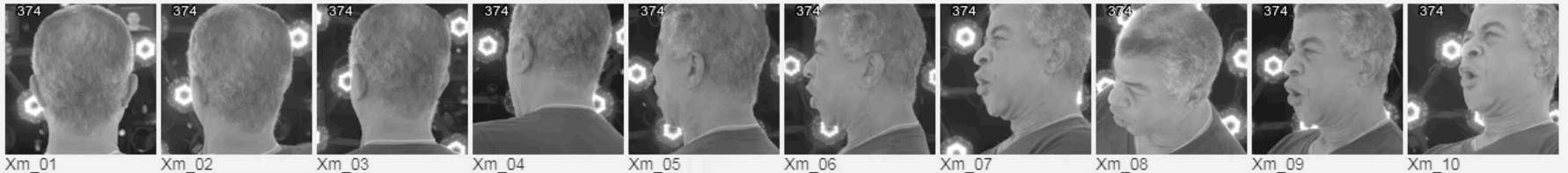
Best :

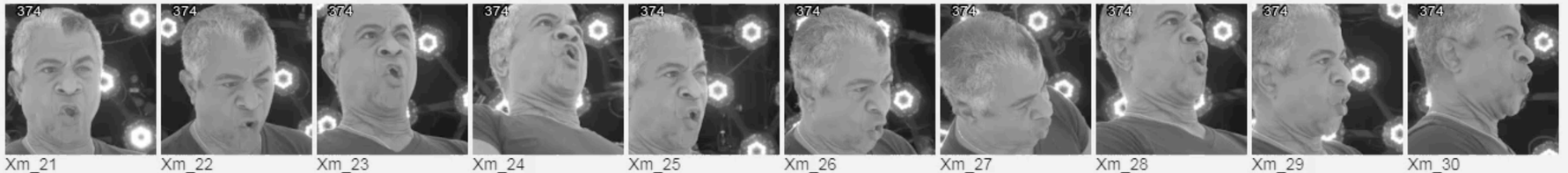
Lightstage Capture (16/16 takes) DSLR Matrix

Neutral (45)
325 frames (Forward Tracking)

Flash (374)

Neutral To Flash





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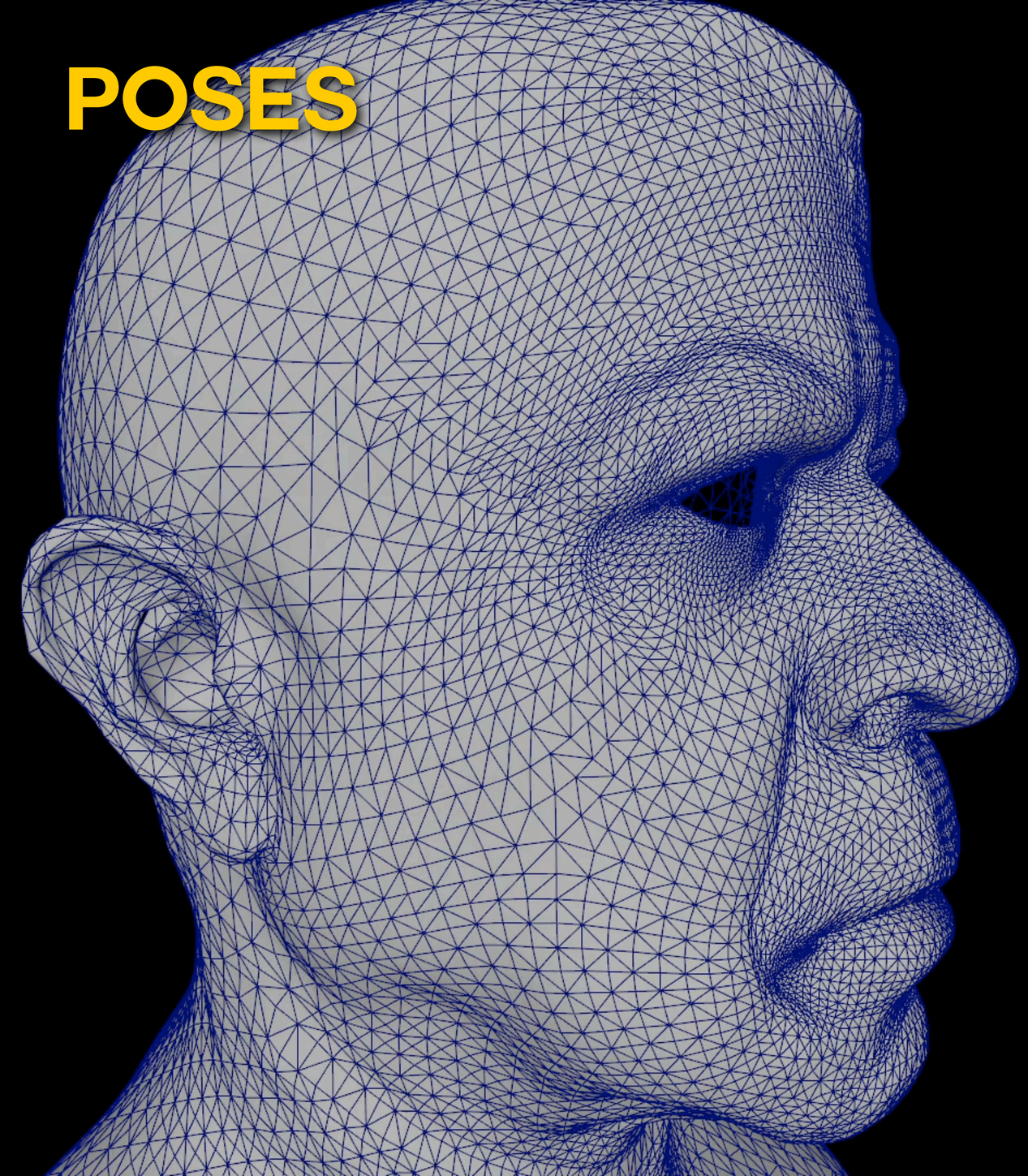

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- animation mesh deformed according to movement observed in multiple views
- each frame of tracked animation mesh is a real state of the face

POSES

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2015_09_22_T_SMALLWC

lightstage.activision.com/take_review.php?proj_id=273&take_id=56162

Zoe Capture - 2015_09_22_T_SMALLWOOD Take Revie

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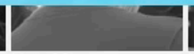
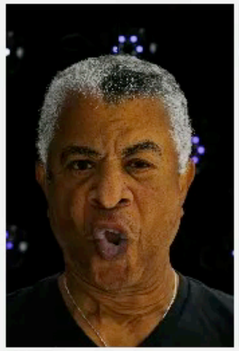
Xm_32


Xm_33


Xm_34


Xm_35

Lightstage Patterns: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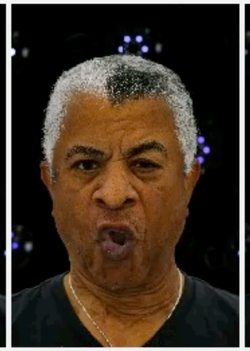
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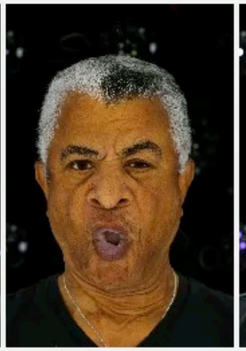
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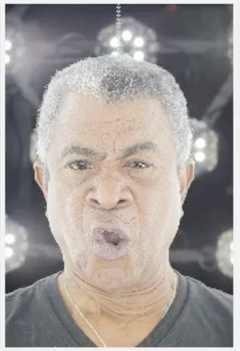
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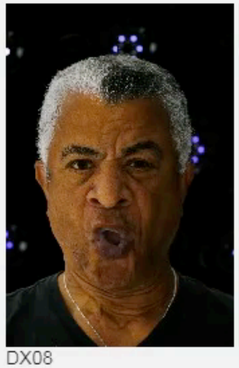
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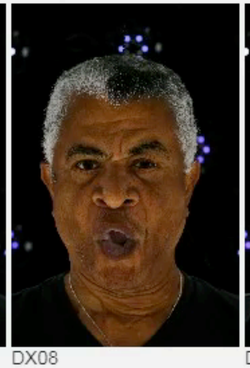
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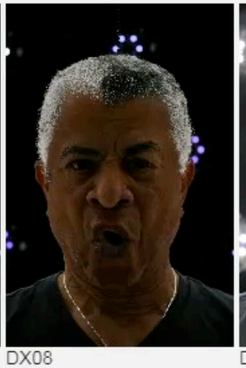
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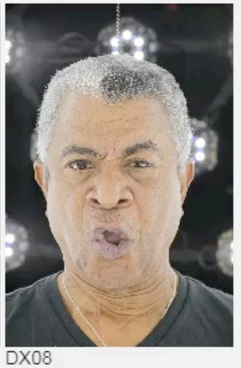
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MAKING BLENDSHAPES

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Regionalization of poses according to rig design

- **up to each game team how they design their facial animation rig and blendshape set**

IMPACT ON PRODUCTION

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Refinements to the tech, developed during Emotion Challenge

- improvements to animation mesh tracking & color pipelines
- streamlined use of intermediate face poses from tracking
- additions to actor pose set for capture session

IMPACT ON PRODUCTION

ACTIVISION CENTRAL TECH

Benefits of incorporated improvements: the numbers

BEFORE

- **blendshape cleanup handled by external vendors: $25,000 per character; 2-4 weeks turnaround time**

AFTER

- **cleanup handled internally: 1-3 days for one artist to do one character**
- **same pipeline became an effective option for background characters**

172 ACTORS SCANNED (BEFORE+AFTER, COMBINED)

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PERFORMANCE CAPTURE

REPRODUCTION IN-GAME WITH EMOTIONAL CONTENT INTACT

PERFORMANCE CAPTURE

Hardware

- technoprops HMC; vertical stereo pair

PERFORMANCE CAPTURE

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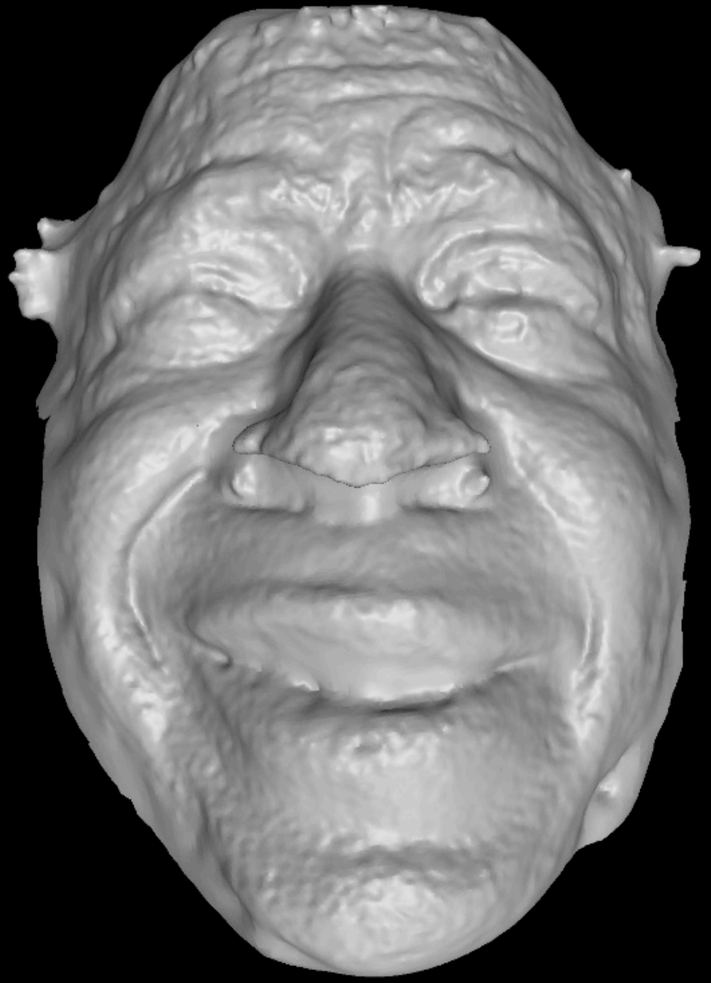
Dense Stereo Reconstruction



PERFORMANCE CAPTURE

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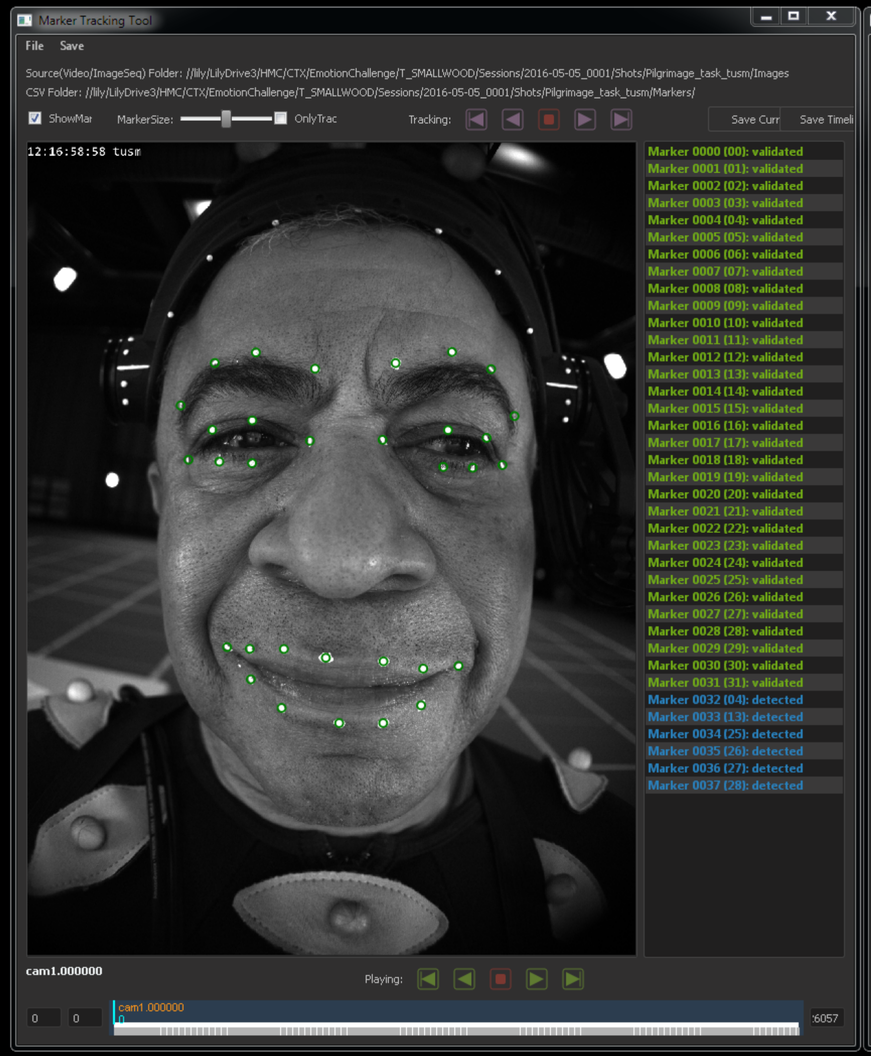
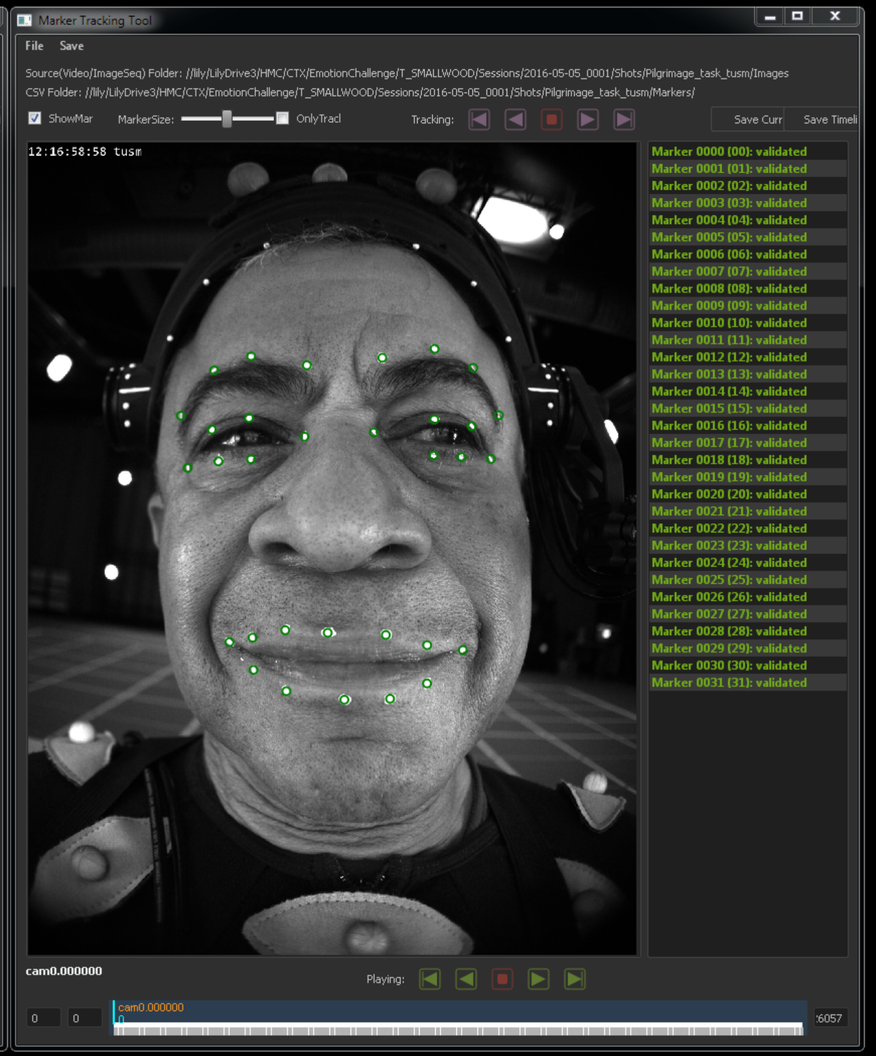
Marker Tracking

- place markers where they most effectively complement dense stereo
- ~40 markers in production shots
- in-house tracking tool





PERFORMANCE CAPTURE SOLVER

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Overview of optimization formulation

- Goal: compute **blendshape weights** and **rigid head transformation** per-frame to fit to measurements
- Approach: coordinate descent
  - Fix rigid transformation; compute **weights**.
  - Fix weights; compute **rigid transformation**.
- For 2D constraints, projection matrices must be known
- Sparseness and temporal smoothness terms


REC

PROTOTYPE

Emotion Challenge Result

- dense stereo + markers around eyes & mouth
- displayed in “Nora” engine
- 3 performances of similar length via this pipeline
- are we done? No, this is the Digital **Production** Symposium

RESEARCH

Controlled conditions to prove what is possible

- minimal head/body movement
- ideal, constant lighting
- no sweat

RESEARCH ≠ PRODUCTION?!

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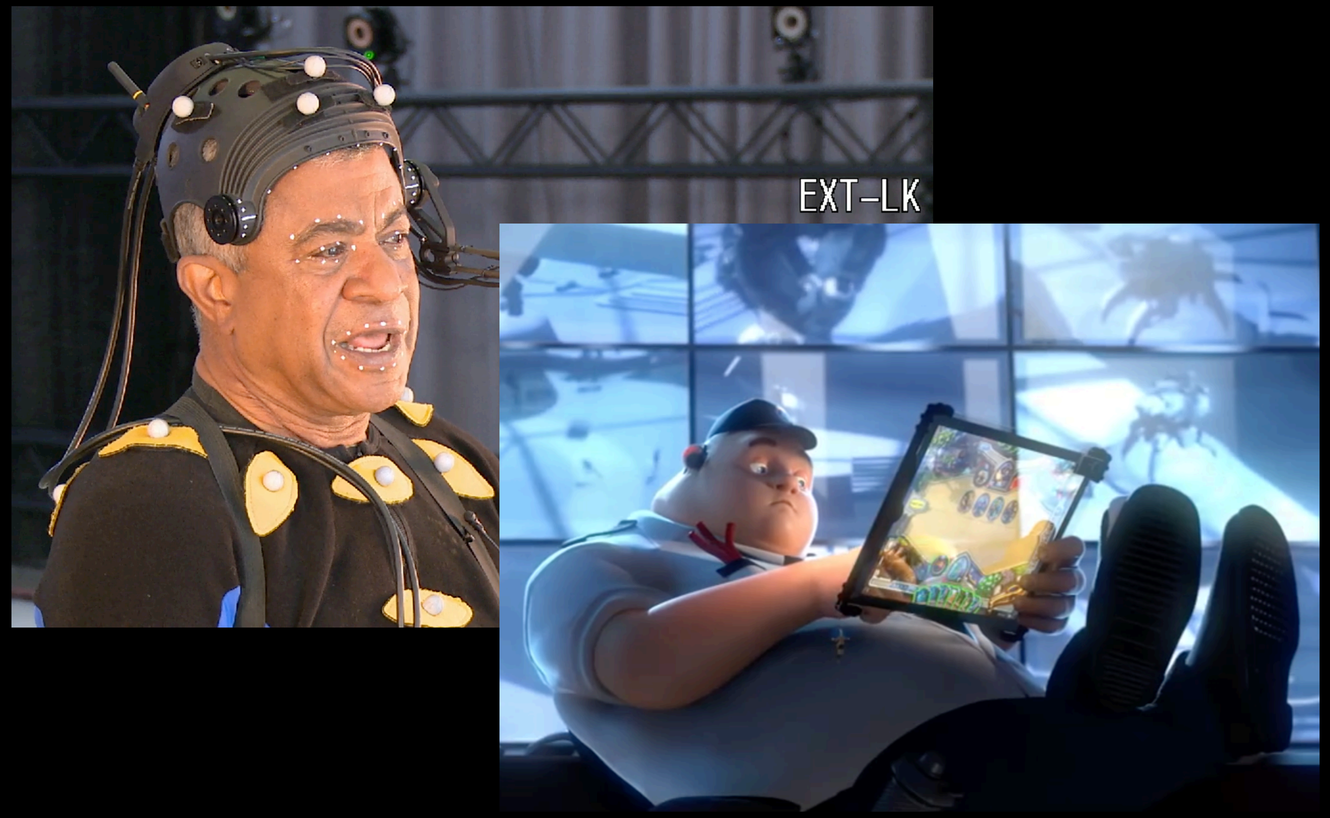

- minimal head/body movement
- ideal, constant lighting
- no sweat

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INPUT DATA IN PRODUCTION

SCENARIOS WHICH OCCUR IN PRACTICE


BEST CASE
TOO DARK
TOO BRIGHT
VARIABLE
OUT OF FOCUS
MOTION BLUR
HELMET MOVEMENT
CAMERA MOVEMENT

INPUT DATA IN PRODUCTION

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Accommodating practical limits on input data quality

- dense optical flow
- options:
  markers
  markers + optical flow
  markers + stereo
  markers + optical flow + stereo
- experimentation with marker layouts
  for best effectiveness under degraded input data conditions

SOLVER SHAPE BASIS

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The solver is no animator

- animation rig blendshapes are not orthogonal
- approaches to animation rig blendshapes vary
  by game team
  by character type
- robustness of solve is highly sensitive to shape basis

PRINCIPAL COMPONENT ANALYSIS

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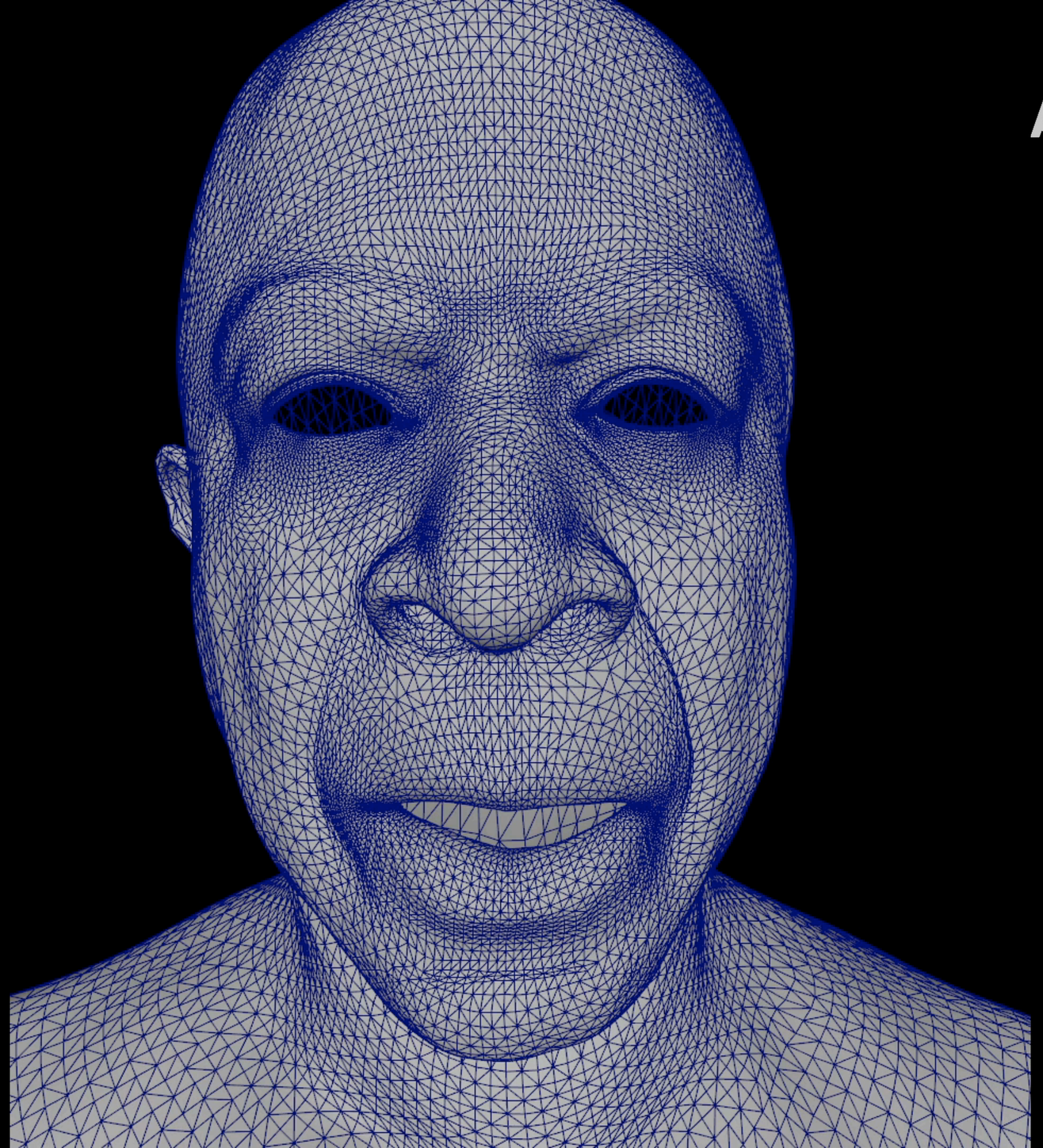
A mathematically-derived shape basis for the solver

FROM REPRESENTATIVE SAMPLES OF FACIAL DEFORMATION:

- **apply PCA to obtain principal modes of the actor's facial deformation**
- **select the PCA shapes accounting for the most significant ~92% of shape variation**
- **leverage inherent weighting (in associated singular values) such that the solver prefers PCA shapes responsible for the majority of variation**

PCA BASIS



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RETARGETING SOLVES

Converting per-frame shape weights
from PCA basis to animation shapes basis

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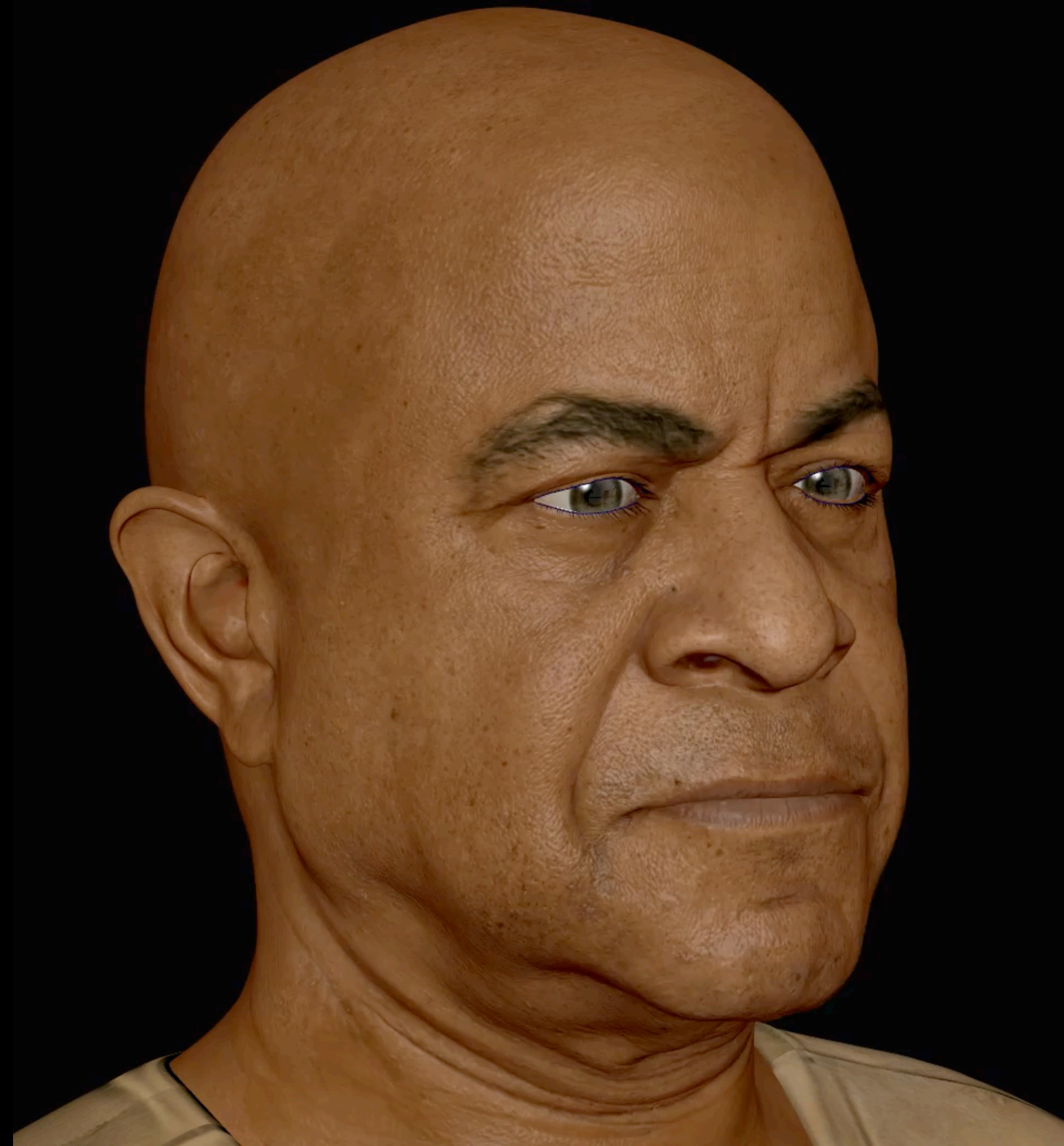
SECOND SOLVE PASS

- **Fit per-frame vertex positions of PCA solve with new solve to animation shapes**
- **Allows tweaking of parameters and iterating**

APPLICATION IN PRODUCTION

- 40 markers + optical flow
- ~90 PCA shapes per actor/character, constructed from approximately 120 shapes
- re-solve to ~70 animation rig shapes



FUTURE DIRECTIONS

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- evaluation of how different aspects of production input data impact solve results
  - make certain aspects more fool-proof
- ROM performances for shapes
- eye performance capture
- targeting stylized human characters; creature characters

ACKNOWLEDGMENTS

ACTIVISION CENTRAL TECH

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ACTIVISION CAPTURE STUDIO

JEN VELAZQUEZ
ANDY HENDRICKSON


research.activision.com