APPLICATION SPECIFIC PROTECTIVE BODY PANELS FOR THE 
ESCHER HUMANOID ROBOT
ELECTROMECHANICAL SERIES COMPLIANT HUMANOID FOR EMERGENCY RESPONSE

ESCHER
INITIAL PANELS
FOR DARPA ROBOTICS CHALLENGE
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INITIAL PANELS
FOR DARPA ROBOTICS CHALLENGE
EXISTING SOLUTION
SAFFIR ONR TRIALS
EXISTING SOLUTION

SAFFIR ONR TRIALS
EXISTING SOLUTION

SAFFIR ONR TRIALS
The protective body panels:

- promote familiarity with the human workers it interacts with on the job

Exterior panels will also provide:

- environmental protection
- impact resistance to vulnerable elements
- high visibility
COLOR STUDIES

EXISTING ROBOTS
Participants were challenged to complete a difficult course of eight tasks relevant to disaster response, among them driving alone, walking through rubble, tripping circuit breakers, turning valves and climbing stairs.
**COLOR ANALYSIS**

- Predominant colors were black, white, gray, and metallic, with blue as the most common accent color.

- 1 pattern

- 1 gradient

- Overall color applications were generally red
FEATURED ROBOTS

BOSTON DYNAMICS

LITTLE DOG

CROWW - SPIDER ROBOT

BIG DOG (ONE SKIN)

BIG DOG (ANOTHER SKIN)

PET MAN
COLOR STUDY
BOSTON DYNAMICS

LITTLE DOG
CROWW - SPIDER ROBOT
BIG DOG (ONE SKIN)
BIG DOG (ANOTHER SKIN)
PET MAN
• Primarily camouflage

• Military application

• Intended to intimidate or be concealed

Conclusion:
While Boston Dynamics is a leader in the robotics industry, their primary application is military. Our robot will need to be easily spotted for safety purposes. Additionally, the design needs to provide more of a sense of comfort to workers who will interact with the robot.
EXISTING COLOR THEORY
COLOR THEORY

RED: a warm-spectrum color, associated with the sun and heat, and can symbolize love, fire, passion, aggression, impulsiveness, excitement, daring, and power. Red can also imply danger or emergency and elicit feelings of aggression and fear. Red can physically speed up heart rate and raise blood pressure (Klimchuk). Meaning red is not a good choice, in that you want people interacting with ESCHER to feel calm.

ORANGE: also frequently associated with the warmth of the sun, energy, exuberance, enthusiasm, adventurousness, cheerfulness, and contentment (Klimchuk). The association to warmth and the sun, connects to the fire-fighting application of the robot, while also embracing a positive association to joy. Additionally, using an accent color of orange connects the design to Virginia Tech – and in doing so, strengthens brand credibility and promotes the University. Orange is frequently used in safety gear and would therefore be associated to caution.

YELLOW: symbolizes life, sun, warmth, idealism, energy, and playfulness. Yellow is a positive color and is used to suggest hope but can also communicate hazard or danger. Yellow is eye stimulating – in fact, the most stimulating color of the spectrum – however, when used in moderation it is the ultimate attention grabber (Klimchuk). Yellow would also be a good accent color for this project, so long as it’s usage isn’t overpowering, but more successful as a yellow-orange blend.

GREEN: symbolizes down-to-earth, tranquillity, life, youth, freshness, and organic. Green communicates recycling, renewal, nature, and the environment. Green can also imply action, good luck, wealth, and money. Thought to be the easiest color on the eyes, green has a calming effect, and its use across many product categories conveys relaxation and peacefulness. On the other hand, green can represent jealousy (green with envy). In many cultures green means “go.” (Klimchuk) Green could possibly be an appropriate choice, if selected as more of a yellow-green “safety” color. While we want interactions with ESCHER to be positive, we also want to make sure people have a certain level of alertness to the encounter.
COLOR THEORY

BLUE: symbolizes authority, dignity, loyalty, truth, and wisdom but can also represent depression, sadness, and solitude. Blue can communicate confidence, strength, conservatism (the blue power suit of Wall Street), trust, stability, and security (police uniforms). Blue can have a peaceful, relaxing feeling (sky blue) or a sobering effect (having the “blues”). The range of colors within the blue family can shift an association from productivity and strength to calmness and relaxation (Klimchuk). Since the computerized components of ESCHER put off a blue glow, there is potential for blue to be used (perhaps even shades of a dark muted navy/gray to compliment other accent colors). More serious tones of blue could be representative of law enforcement / military uniforms, which would carry a tone of respect. However, blue as an accent seems to be overly common in other robots.

PURPLE: historically purple pigment was difficult to acquire through natural sources. In fact – the word purple comes from the snail or mollusk, purpura, and the coloring agent from its mucus glands – and therefore it was rare, expensive, and used primarily by wealthy nobility or high priests. In its deepest tone purple can bring about a sense of peace but also depression and darkness (Klimchuk). Purple is not an appropriate color selection for the ESCHER project.

BLACK: can symbolize sturdiness, reliability, constancy, and wisdom, and it resonates power. Black can create a perception of depth and communicate strength and clarity. In Western cultures, black can be the color of despair and mourning, and can be associated with evil (Klimchuk). Robots can be quite intimidating to humans, and we want to make the ESCHER robot approachable. Therefore black would not be a wise color choice, unless paired with larger swaths of bright colors (which would liven-up the entire robot). If neutral colors are desired, a shade of gray would be recommended.

WHITE: communicates purity, freshness, innocence, cleanliness, efficaciousness, truthfulness, and contemporariness. White can connote snow or coldness. White reflects light and makes the colors around it stand out (Klimchuk). White packaging most easily shows imperfections – and since, particularly at this stage, we are working on an evolving project (one where modifications will regularly be made) – it would be wise to select a more forgiving color. However, if this is not a concern, white does convey health and technology in a positive way.
IN SUMMARY (COLOR)

What we want to accomplish:

• high visibility

• promote familiarity with the human workers (i.e. make it approachable / not “scary”)

• be representative of virginia tech in a professional manner

What we want to avoid:

• looking what is already in existence (we want to establish brand positioning)
PROPOSED
COLOR PALETTE
PROPOSED COLOR PALETTE

- Accent color Orange (high visibility, connection to VT)
- Primary body color light gray (lighter color = friendlier)
- Accents of darker gray/black to help forms pop - and found within existing exposed areas of the ESCHER robot
FINAL COLOR (MORE INDICATIVE OF "NAVAL" COLORS)

COLOR PALETTE
ADDITIONAL REASONING FOR PROPOSED COLOR SELECTION

• Orange is easy to spot in the daytime
  “A 2009 study by the U.S. Fire Administration (USFA), a division of the Federal Emergency Management Agency (FEMA), also concluded that fluorescent colors, including yellow-green and orange, are easiest to spot in daylight.”
  - from the American Psychological Association

• Overall lighter colors are friendlier and easier to see
  “Firefighters wearing black gear felt there were visibility issues with black gear, particularly at night. Even though all [firefighting] gear must have a certain amount of reflective tape, regulated by the National Fire Protection Association, reflective properties are often diminished by repeated washing or residual dirt and soot from fighting fires that builds up on the tape.”
  - from Color and Design
EXISTING DESIGNS, UNIFORMS
NAVAL INSPIRATION
NAVAL UNIFORM INSPIRATION

Bomb Suit (left)

• Has a reinforced helmet that is blast-resistant and air-cooled. (Could help keep the robot/computer cool and protected)

Deep Sea Diver (right)

• The placement of accent colors for visibility could be an alternative.
NAVAL UNIFORM ANALYSIS

Navy Working Uniform 3
Flight Suit
Navy Working Uniform

• Since the primary function of these sort of uniforms is to camouflage the wearer, they would not be appropriate inspiration for this project
EXISTING DESIGNS, CURRENT USAGE

FIRE-FIGHTING COMPONENT
FIRE-FIGHTING SUIT

Suit Materials:

• Externally, fire-fighting suits have bands of neon and reflective materials

• The high-visibility materials are applied in bands, so they can be seen easily from any angle
MATERIAL RECOMMENDATION

- Reflective material should be considered for incorporation (high visibility)

- Reflection is similar to motion in how it is perceived by the eye, and motion is the first element that can be visually perceived.
  1. Motion is first perceived
  2. Color is second to be seen
  3. Form is tertiary

- When used near a fire, reflective material is highly effective, as the flames cast off light – and the reflections can be more easily be seen through smoke

- However, reflective material can deteriorate over time, so durability or replacement factors should be considered (DeLong)
NOMEX AND KEVLAR

Suit Materials:

- Fire-Fighting Suits are Primarily made of Kevlar and Nomex - both of which have distinctive patterns (particularly the honeycomb) that could be applied to the design
Pros:

- assists firefighter in carrying gear, which typically weighs 50+ lbs.

Cons:

- not yet functioning
- still puts humans at risk

*Not our direct competition.*
INSPIRATION
MOOD BOARDS
AVOID: THE UNCANNY VALLEY
AVOID: OVERLY HUMAN
AVOID: OVERTLY GENDERED
AVOID: CUTE
AVOID: FRIGHTENING
INSPIRATION: AUTOMOTIVE
INSPIRATION: ARCHITECTURE
INSPIRATION: INDUSTRIAL DESIGN

- EVA/POLYETHYLENE: Lightweight and versatile, ideal for high-impact areas such as the chest and back.
- MULTIDENSITY FOAMS: Low density foam reinforced with high density foam for maximum shock absorption and protection.
- IMPAX H.D. FOAM: Urethane foam designed for high impact and static loads, ensuring the dispersion of energy from impact.
- TRANSPARENT POLYETHYLENE: Innovative material that is not only protective but also allows visibility.
- ALUMINIUM RIVETS: Stylish and lightweight aluminium rivets complement the sleek design, adding a touch of durability and aesthetic appeal.
INSPIRATION: MOTORCYCLE GEAR
OVERALL DESIGN DIRECTION
REFERENCES

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- Boston Dynamics
  www.bostondynamics.com


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  www.theroboticschallenge.org


- IEEE
  www.ieee.org


- News Discovery (Fire-fighting suit)
  news.discovery.com/tech/robotics

- Robots App by IEEE
  robotsapp.spectrum.ieee.org

- United States Navy
  www.navy.com/about/uniforms

- WIRED magazine
  www.wired.com
EARLY RENDER

BANDED COLOR
CONCEPT: BOAT
- CURVY STREAM LINE
- ORGANIC SHAPES
- MIDNIGHT

SHAPES ARE FLOWING CONTINUOUSLY BUT IN PIECES
SLOWER FLOW

MORE DETAILS

LOW POLY MAKE EASY

APPLIANCE (CURVE) WITH COBE)
EARLY FORM RENDERS
SELECTED DIRECTION
BODY PANEL DEVELOPMENT
BODY PANEL DEVELOPMENT

NOTE FOR REVISION: TOO "BOXY"
ATTACHMENT TESTING
PAUSE + PRESENT

SXSW 2016

ESCHER Humanoid Robot
Application Specific
Protective Body Panels
SXSW

PAUSE + PRESENT CURRENT STATE
MINI ESCHER

1/3 SCALE MODEL
PROCESS WORK
OBJET PRINTS
TOO MUCH TIME IN THE BOOTH...
LEG DEVELOPMENT

NOTE FOR REVISION: TOO DRAMATIC / LARGE
PANEL FITTING
TESTING IN TREK LAB
NAVAL APPLICATION

WET SUIT CONCEPT
NANOSONIC
PUTTING NANO TECHNOLOGY TO WORK
PAPER PATTERN
(THANK YOU TO ALISON OWEN & JANE STEIN & SOPA!)
REFLECTIVE VINYL + COLOR
SUMMER PROGRESS

ONR DEMO
ONR DEMO
SUMMER STATUS

CURRENT REVISIONS: PAINT AND ADDITIONAL PANELS
THANK YOU

THANK YOU TO ICAT AND ALL THOSE IN ATTENDANCE TODAY WHO CAME EXPECTING MUFFINS AND INSTEAD GOT THIS TALK.