Unveiling Solutions to Societal Challenges Through Computer Simulation

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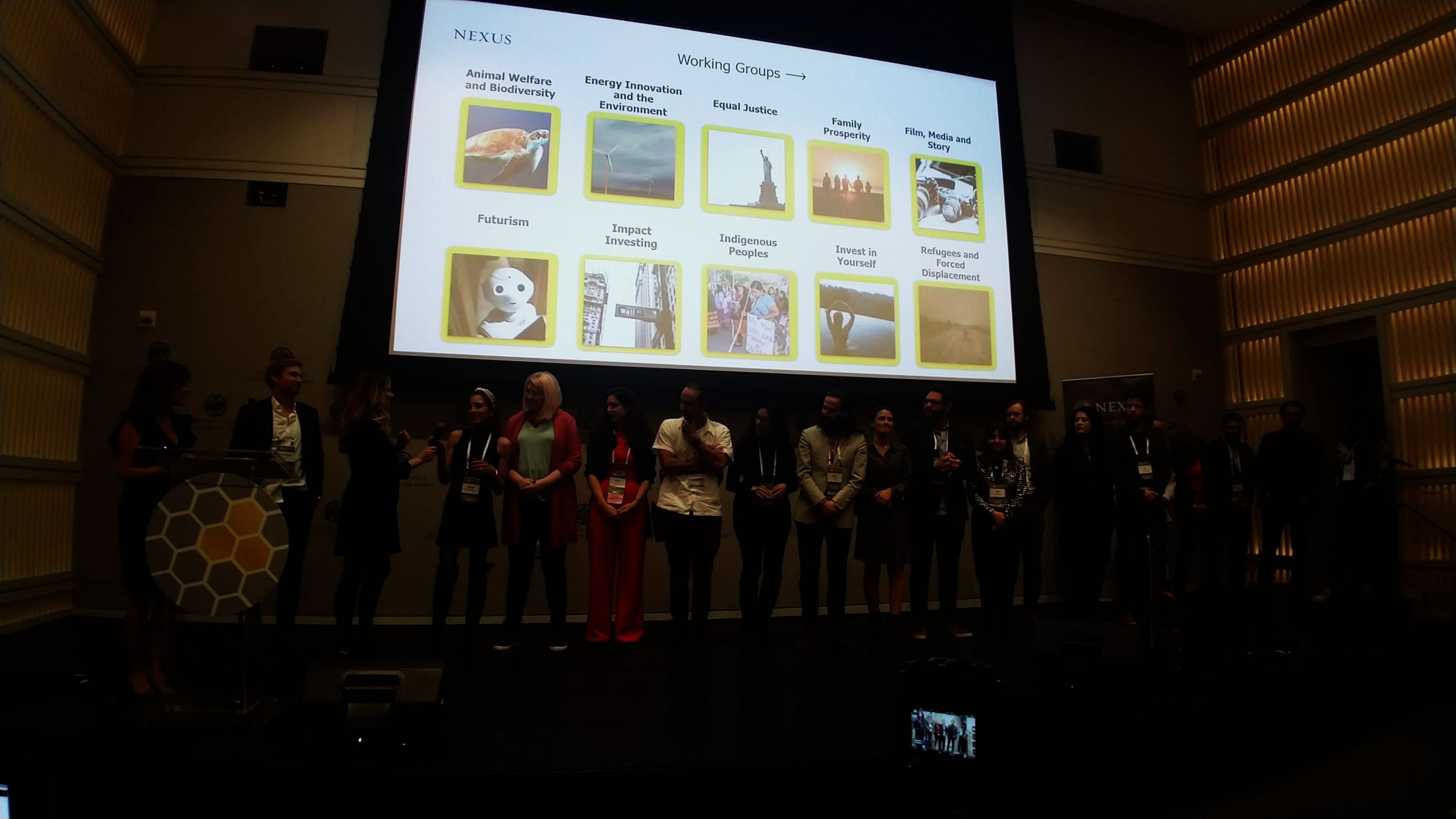
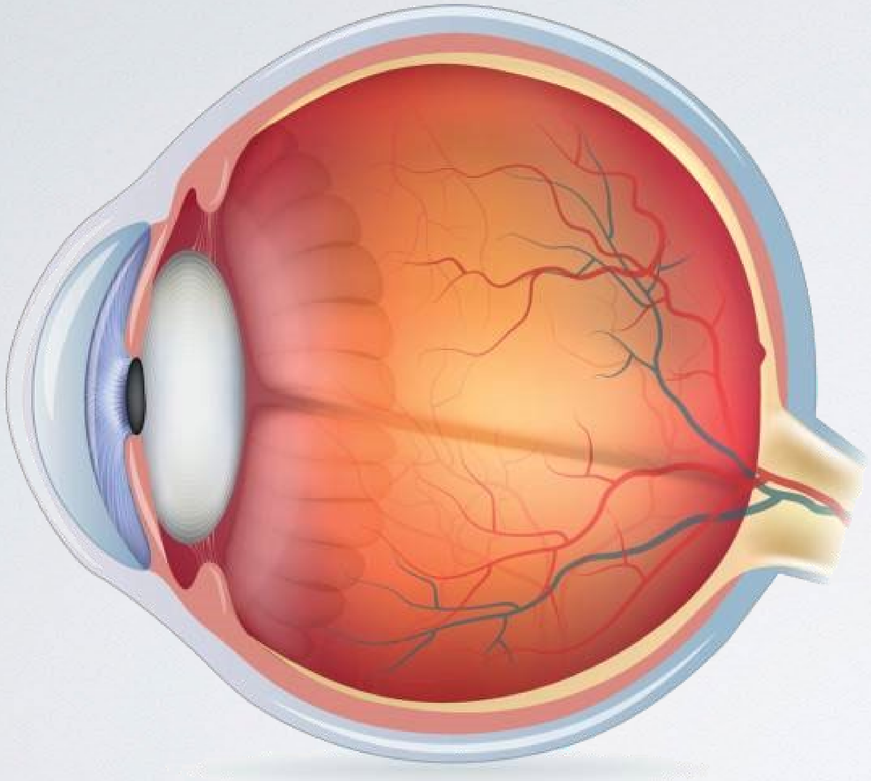

NEXUS
Working Groups ⟶
Animal Welfare and Biodiversity
Energy Innovation and the Environment
Equal Justice
Family Prosperity
Film, Media and Story
Futurism
Impact Investing
Indigenous Peoples
Invest in Yourself
Refugees and Forced Displacement
Wall St

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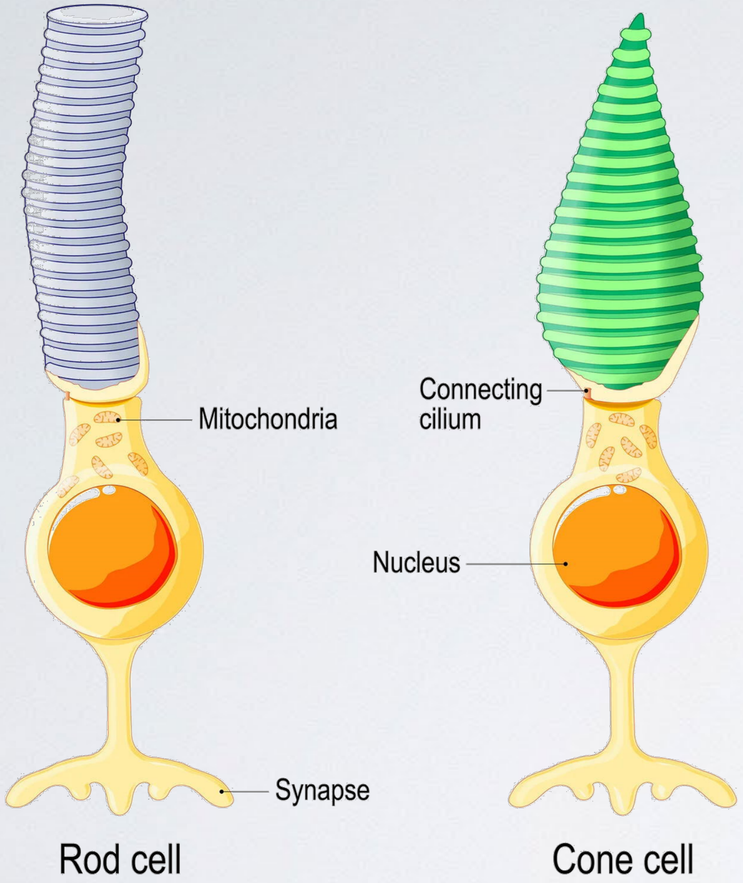
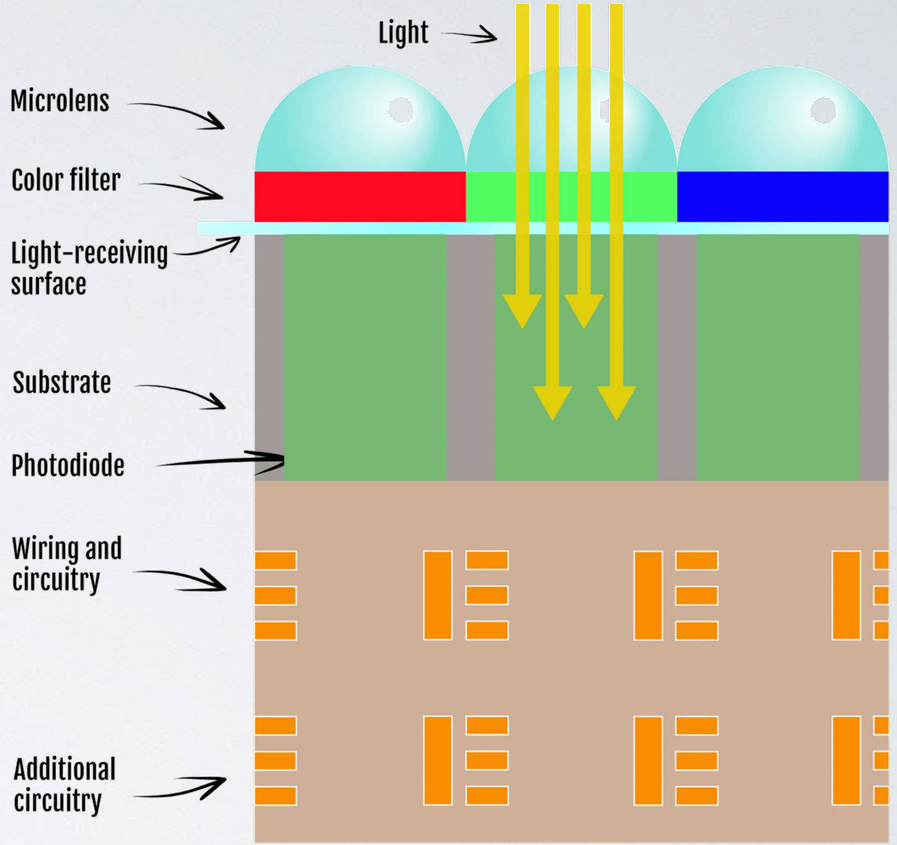
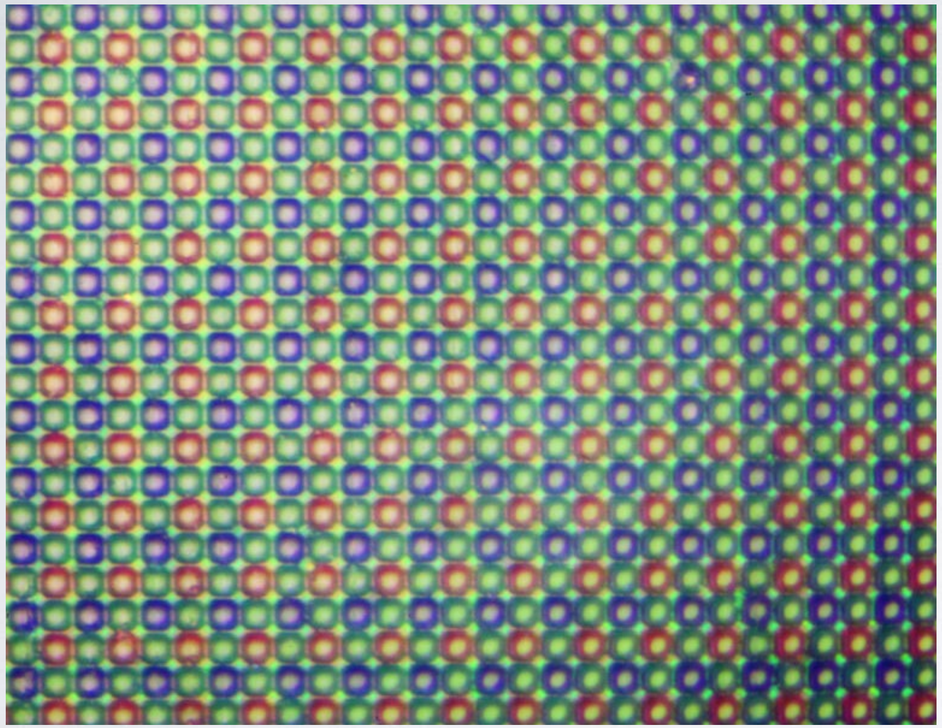

Mitochondria
Synapse
Connecting cilium
Nucleus
Rod cell
Cone cell

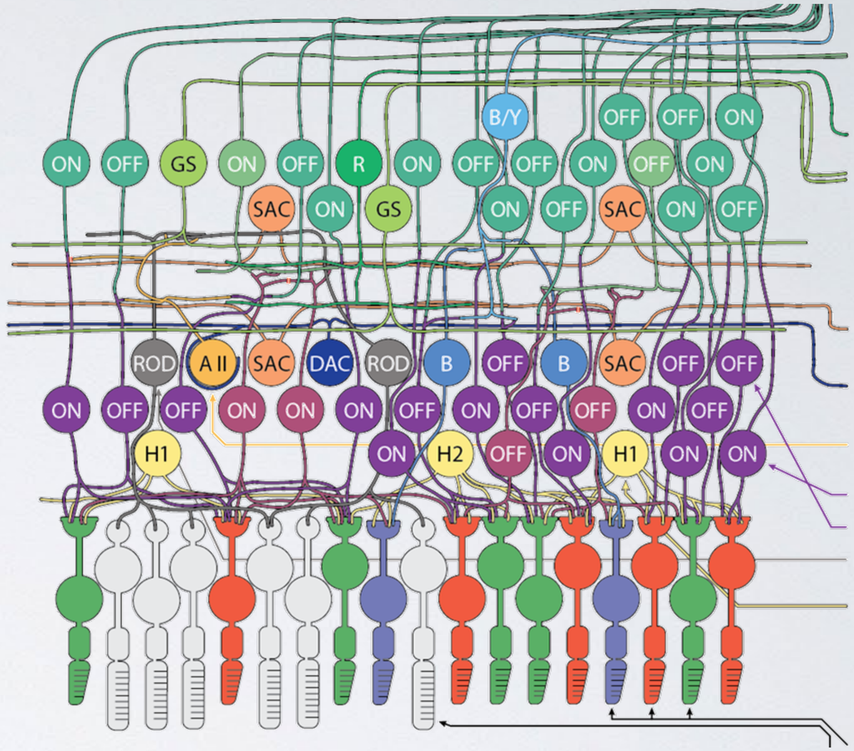

Light
Microlens
Color filter
Light-receiving surface
Substrate
Photodiode
Wiring and circuitry
Additional circuitry

Deterministic

BEHAVIORS

Emergent





Independent

ELEMENTS

Interacting

Definition of “emergent behavior”

A system’s behavior is said to be emergent if it cannot easily be explained or predicted from the behavior of the individual elements

*Many human systems are also complex (*i.e., *they exhibit emergent behaviors)*

Stock markets

Sports

Traffic jams

All examples of *Complex Systems*

A system is said to be complex if:

1. It consists of many *interacting elements*
2. The system exhibits *emergent behaviors*

Virtually every societal problem you may be interested in tackling is a complex system!

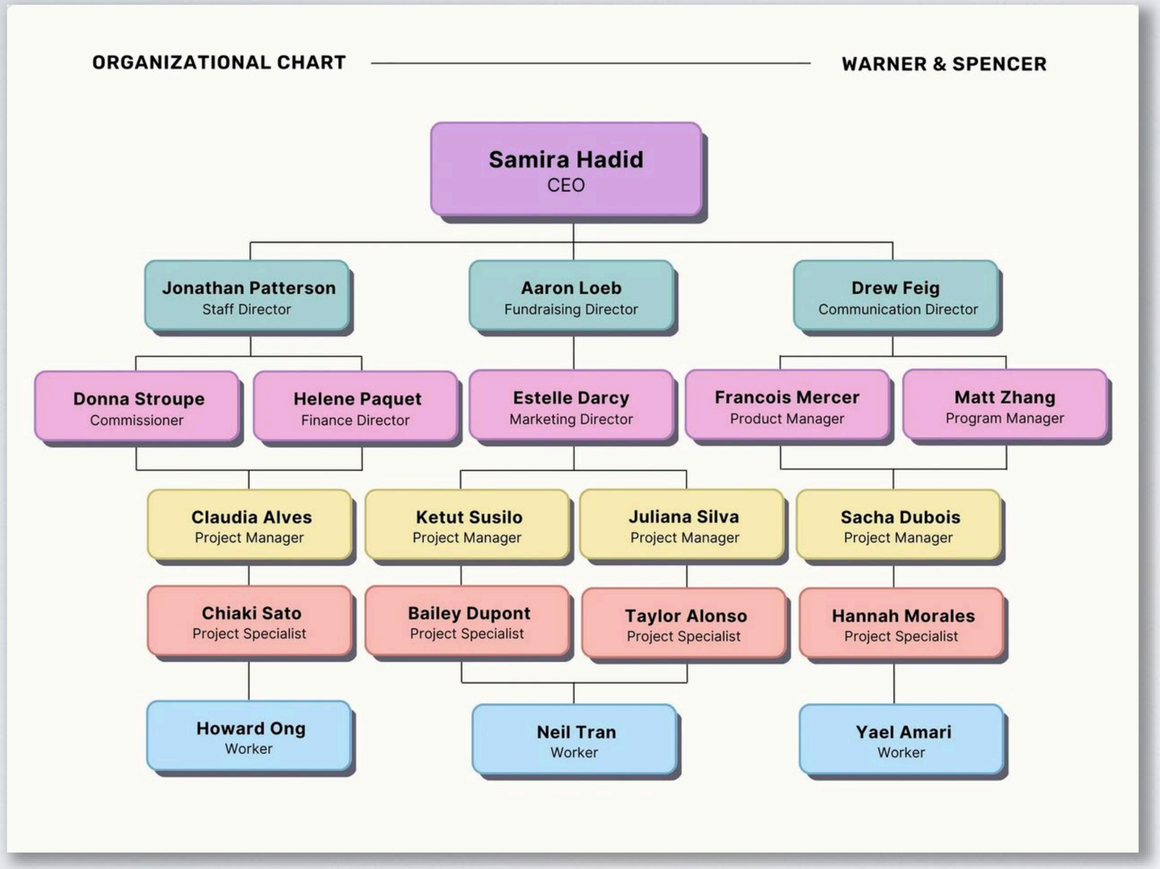
The nonprofit's *alleged* goal

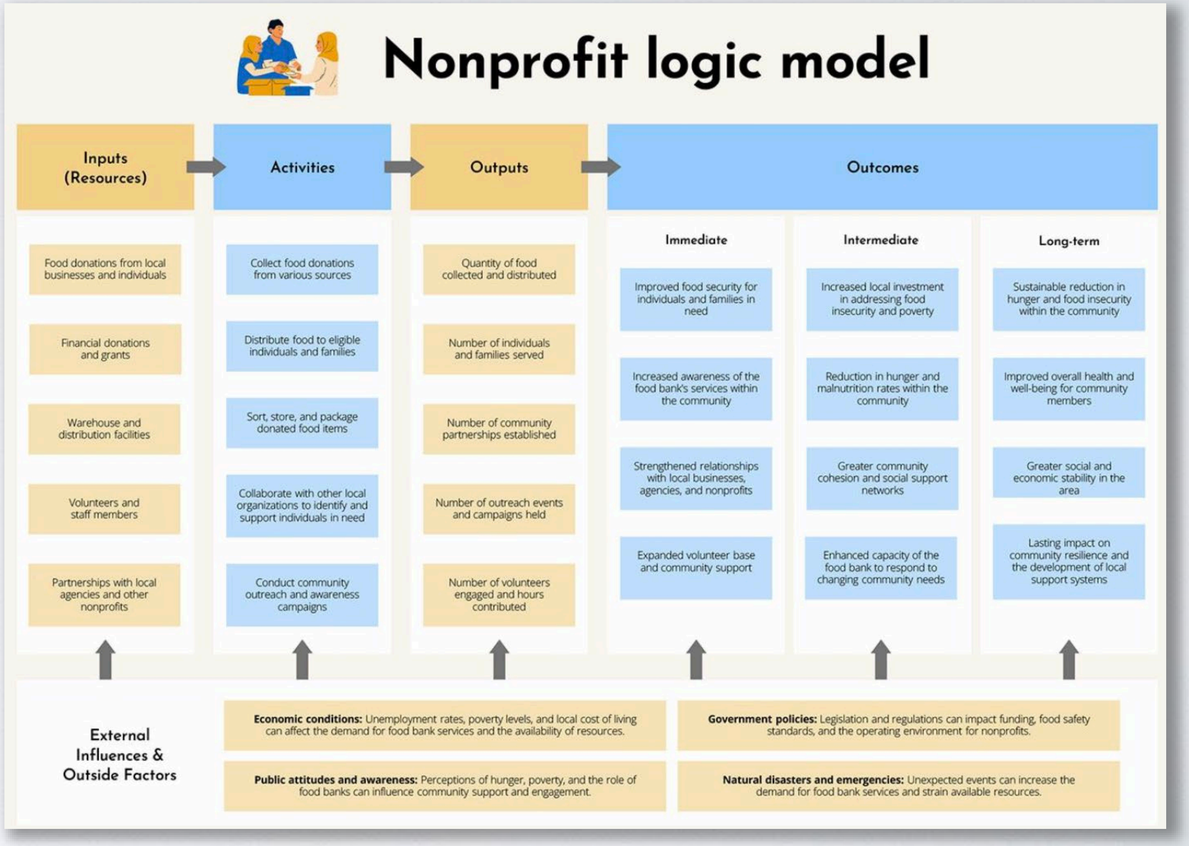
How do we design our programs to achieve desired outcomes and impact?

The nonprofit's *actual* goal

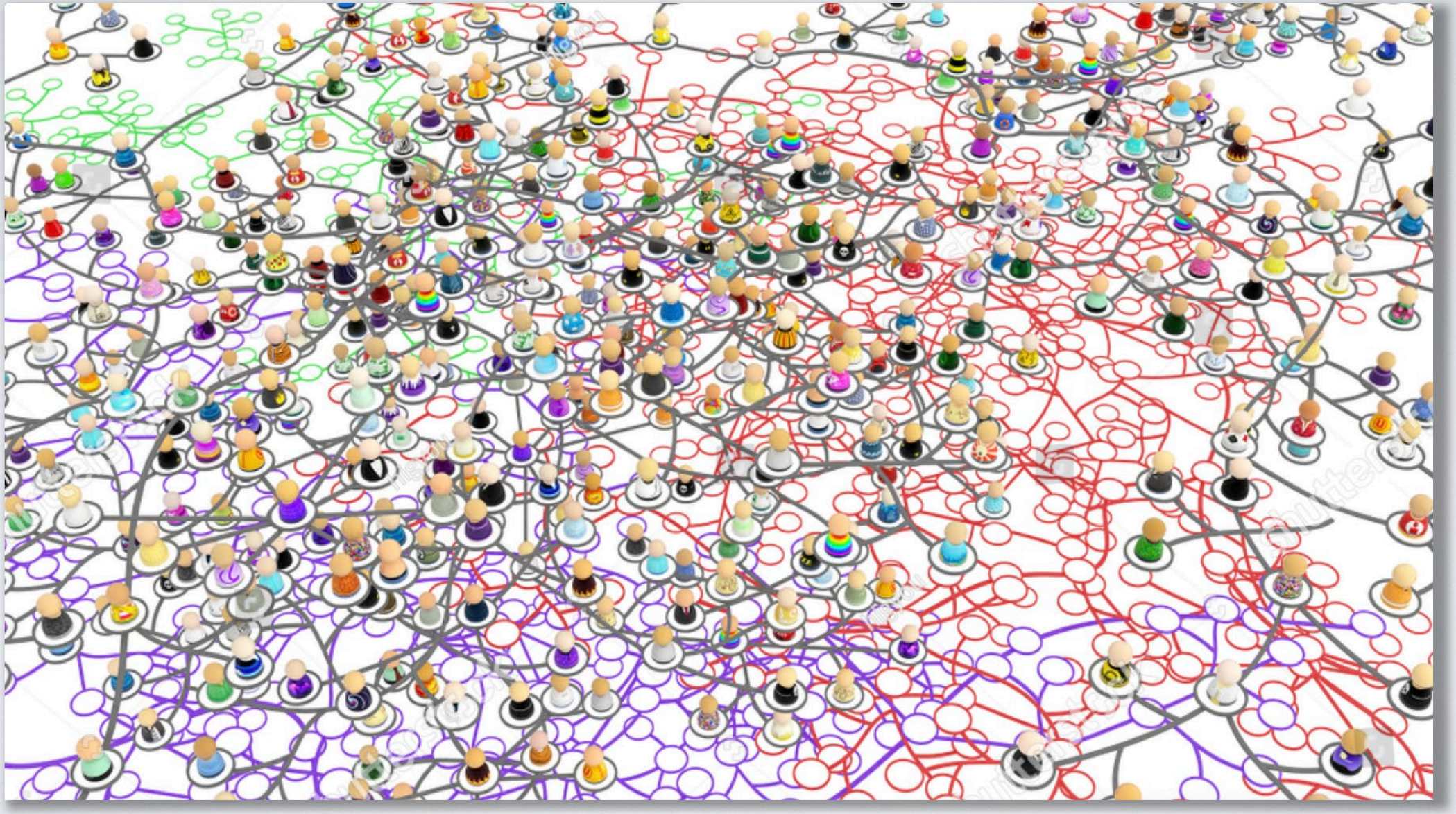
How do we define individual behaviors and interactions to produce desired emergent behaviors?

The illusion





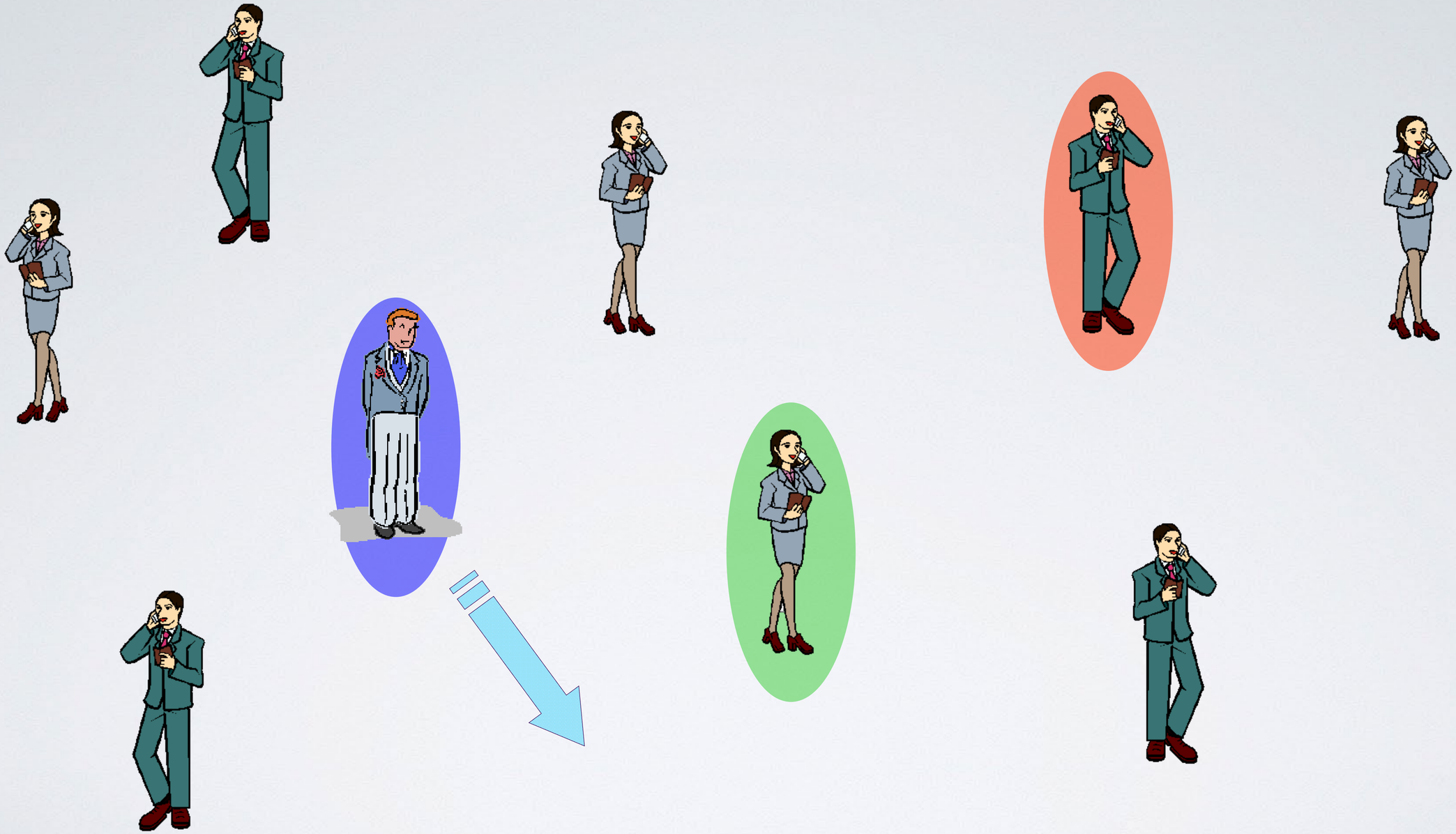
The reality

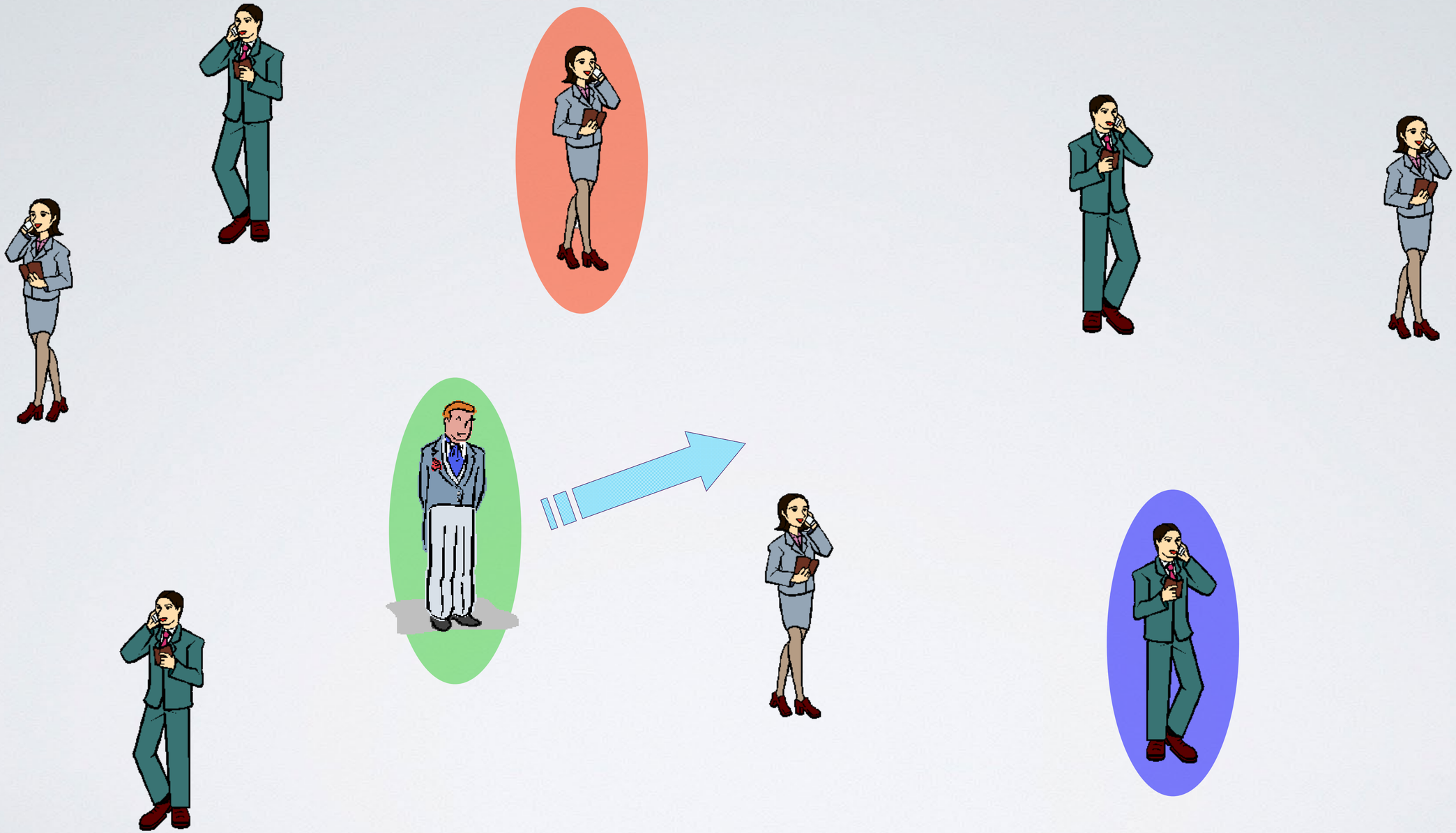


A further… complication

A system does not need to be complicated in order to be complex!

The aggressor-defender game





Version 2 always leads to “clustering”

Why should we care?

- Knowing the behavior of every individual is not enough to predict system behavior
- Slight changes in rules or interactions can lead to dramatic changes in system behavior

We need a different approach!

A human-centric approach: *Agent-Based Simulation (ABS)*

Behavioral Sciences
to understand individual behaviors and attitudes

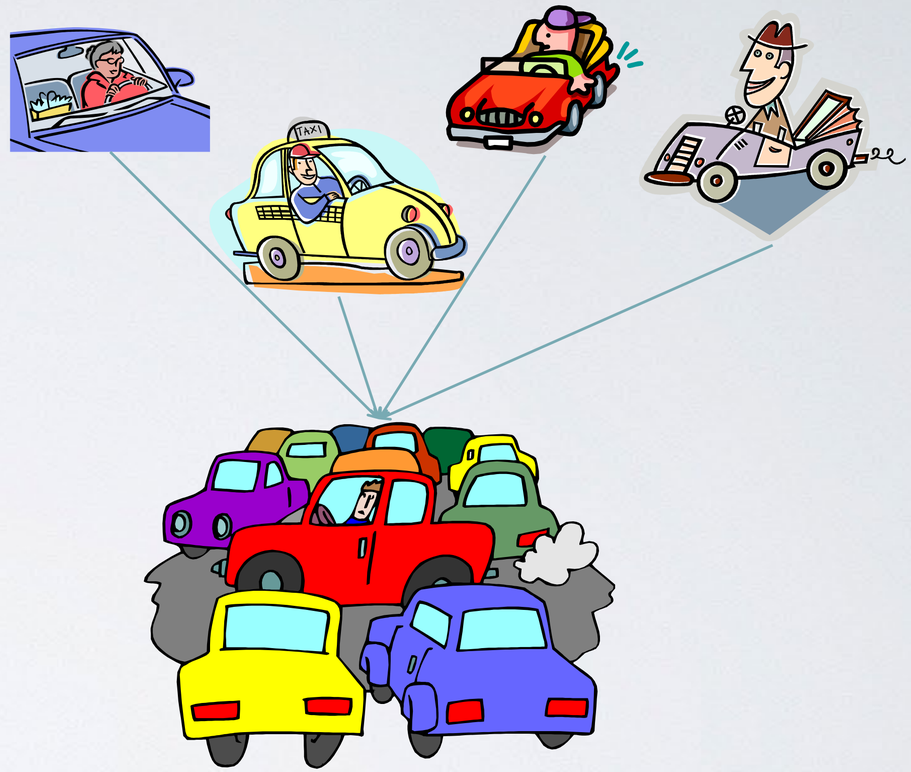
+

Computer Simulations
to capture interactions between individuals

Traffic jams

ABS: a human-centric approach

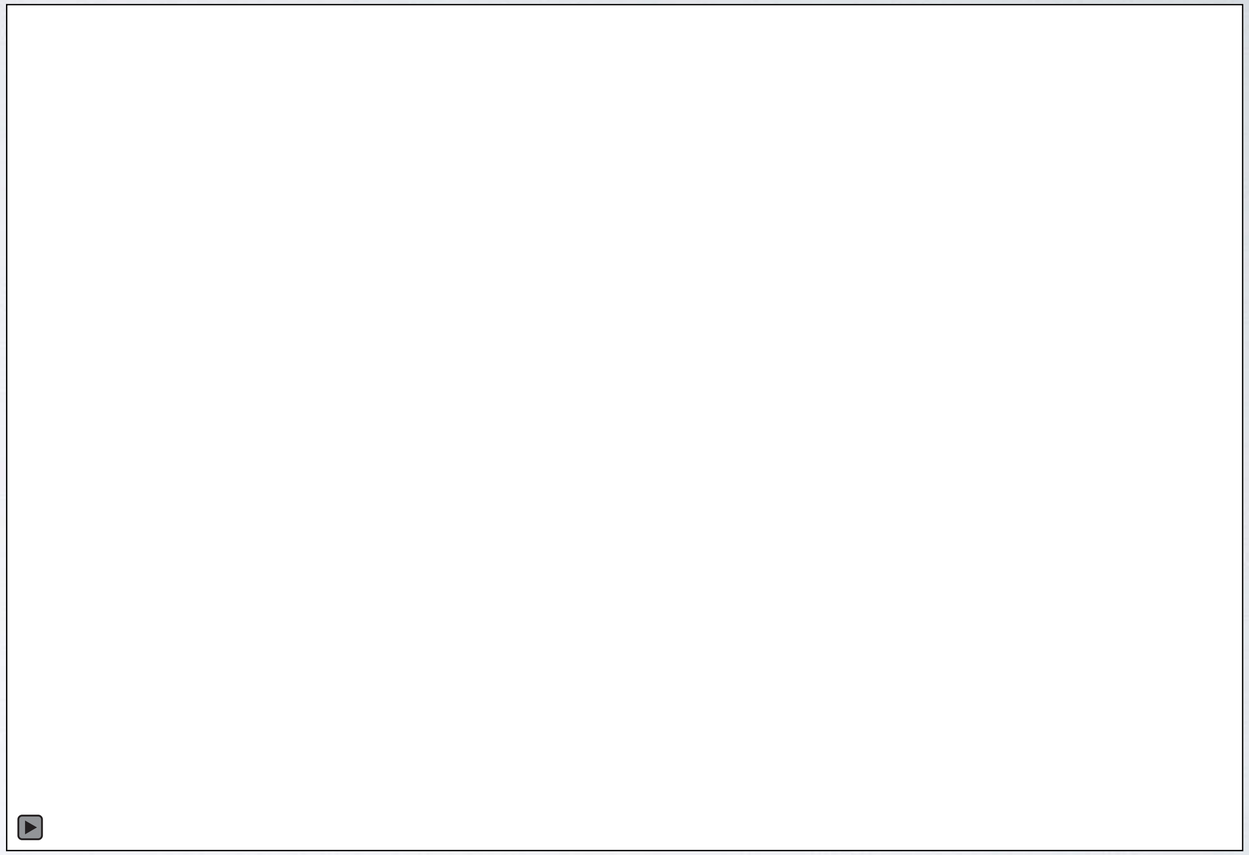
- Simulate the behavior of individual drivers (driving style, start/end points, response to conditions...)
- Adjust behaviors until overall traffic patterns are replicated accurately



What are typical driving behaviors?

- If there is nobody ahead, accelerate
- If there is someone ahead, hit the brakes
- Avoid collisions
- Stay on the road

We can build an Agent-Based Simulation in NetLogo!



Wilensky, U. (1997). NetLogo Traffic Basic model. http://ccl.northwestern.edu/netlogo/models/TrafficBasic. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

ABS in a nutshell

- Shift viewpoint from system (top down) to individual elements (human-centric)
- Each agent follows its own rules
- Behavior depends on interactions with other agents and environment
- Overall system behavior *emerges* from local interactions

Sample applications

Improving Entry-Level Job Opportunities for Youth

Client

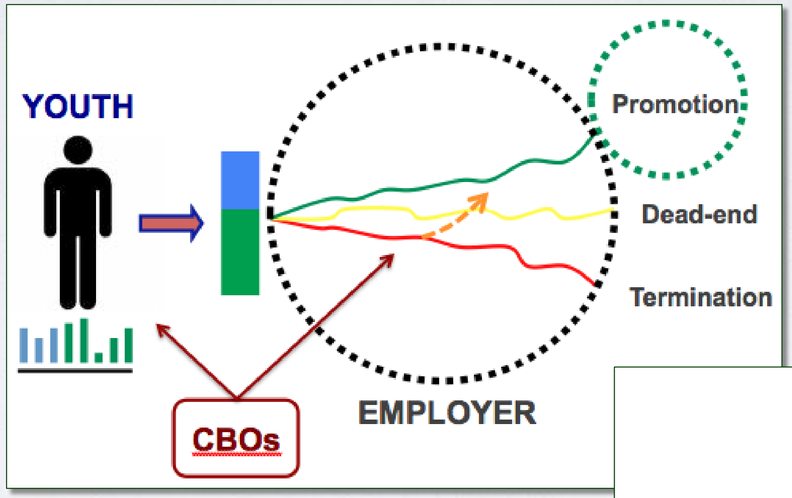
- W.K. Kellogg Foundation

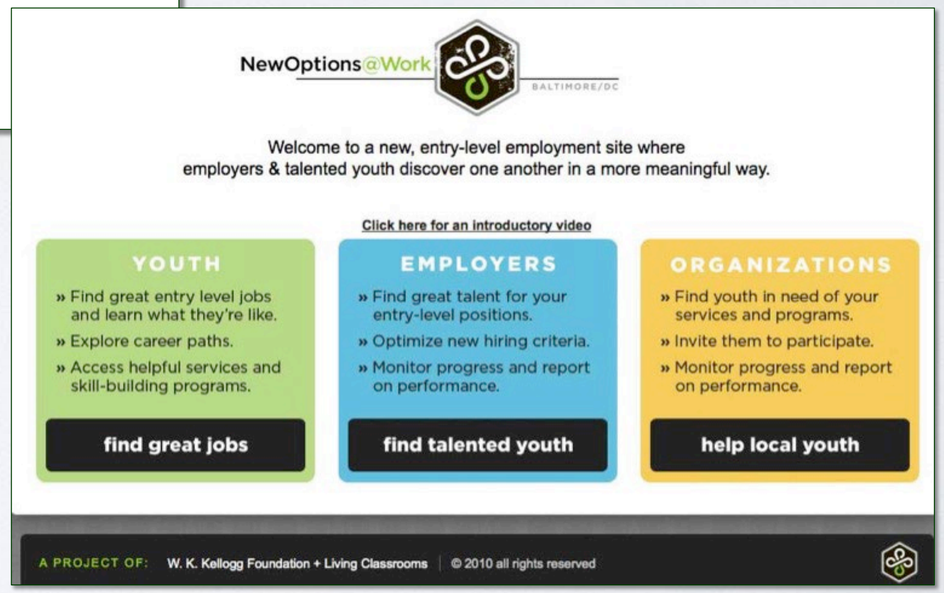
Challenge

- Identify non-traditional skills to help at-risk youth succeed with entry-level positions
- Show value of non-traditional skills to employers

Outcomes

- Developed simulation of employer “path” through entry-level position
- Identified quantitative metrics to maximize success





Exploring fishery sustainability

Client

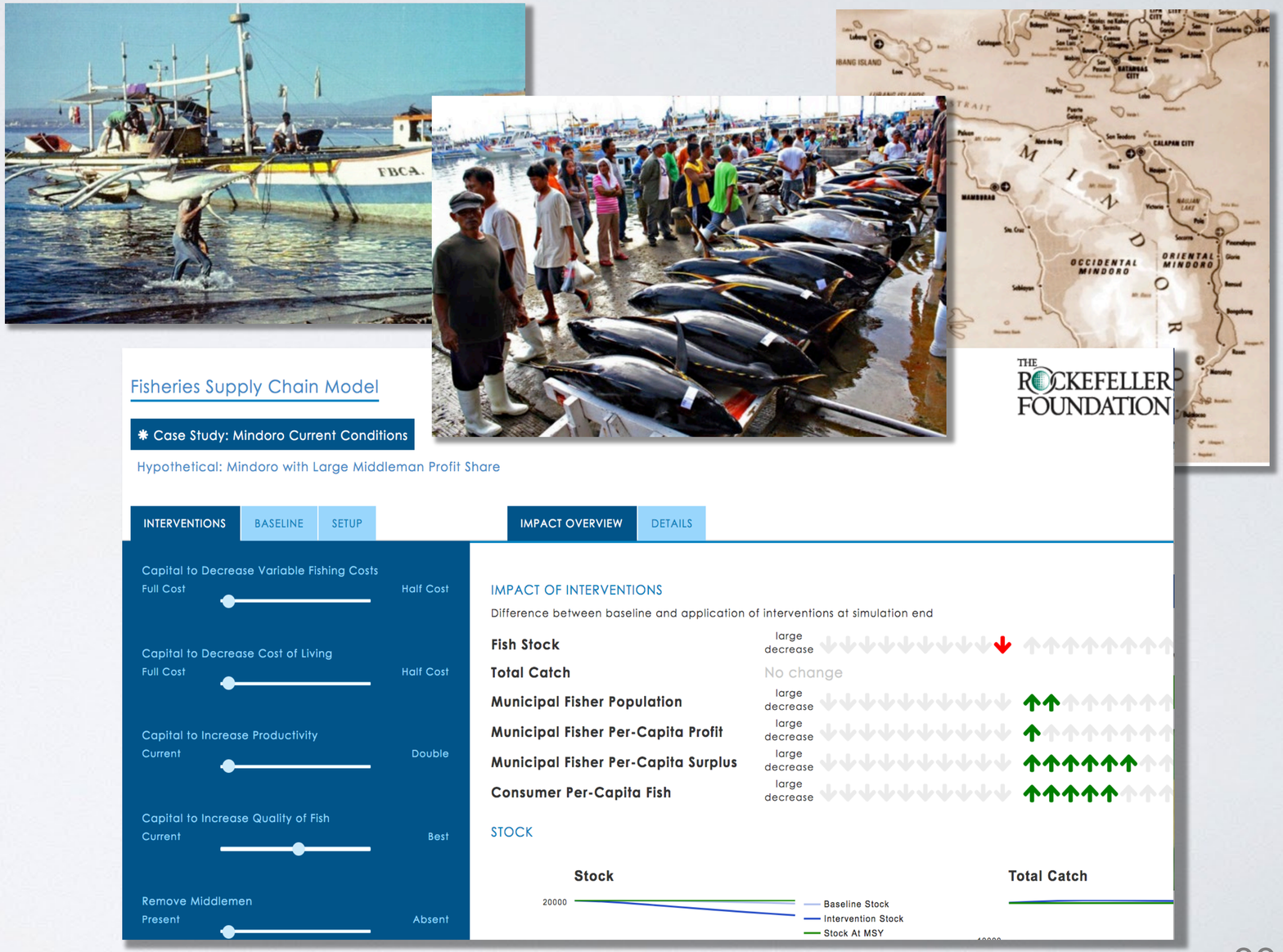
- The Rockefeller Foundation

Challenge

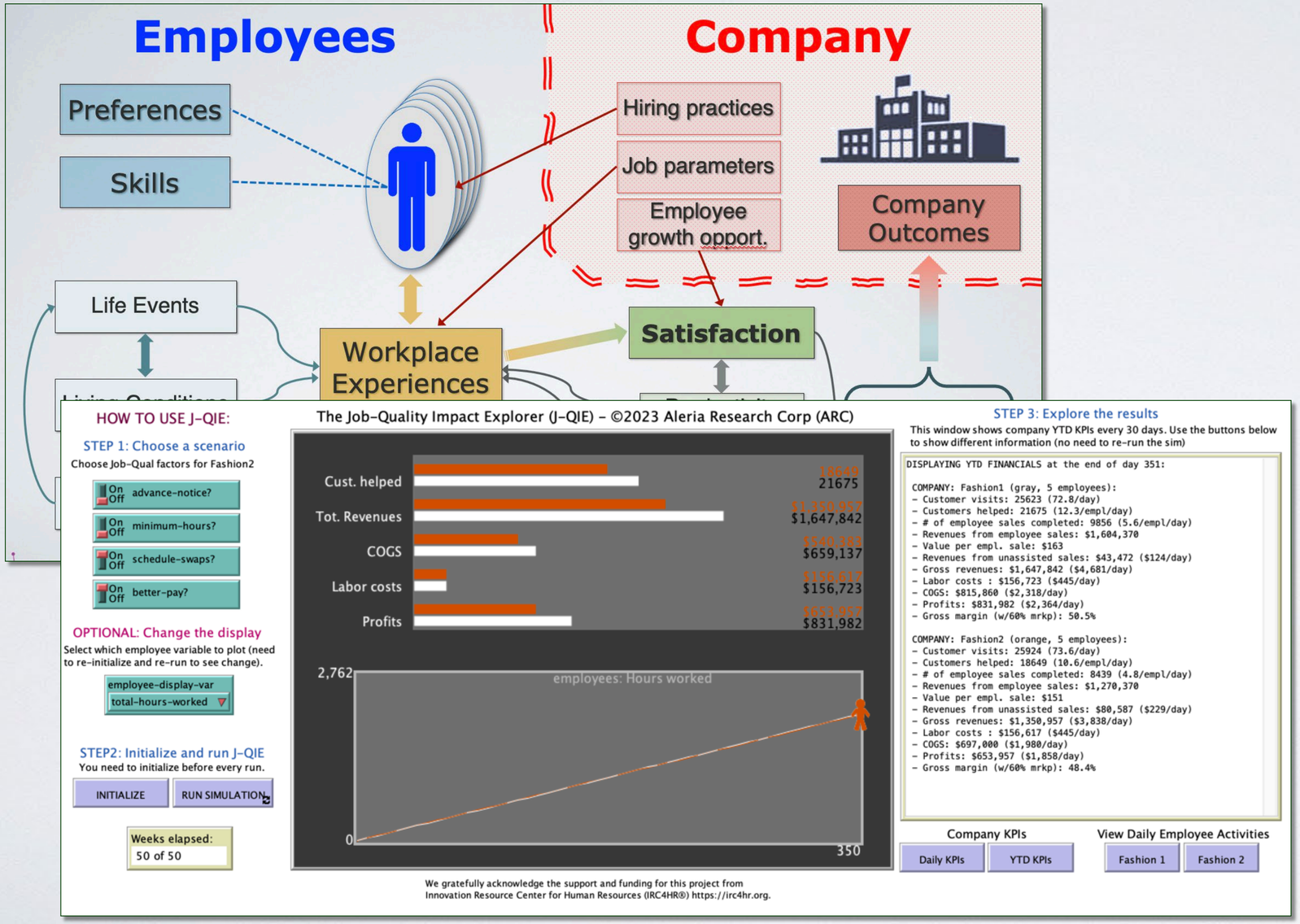
- Explore tradeoffs in the management of the Mindoro fisheries

Outcomes

- Developed simulation including dynamics pf the fish populations and of the local economy and welfare
- Created interactive dashboard to test out a wide range of *what-if scenarios*



Better jobs for front-line workers



Client

- Innovation Research Center for Human Resources

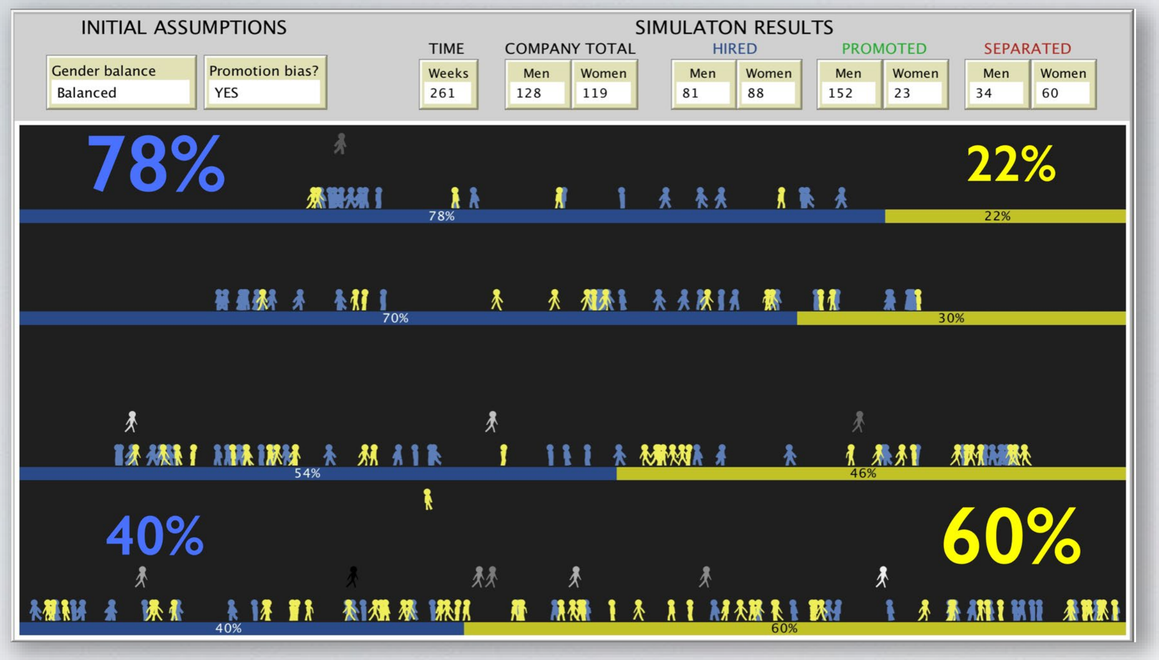
Challenge

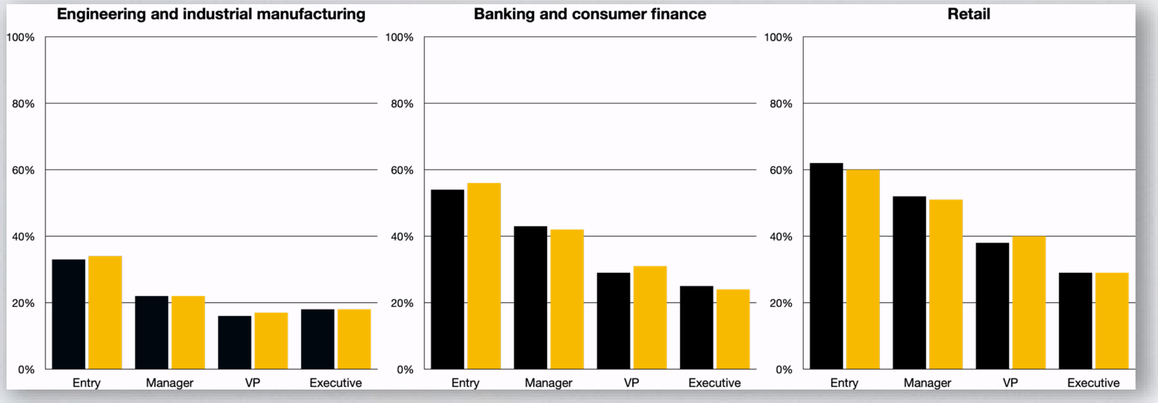
- Show the positive financial impact of improving job quality for front-line workers

Outcomes

- Developed **J-QIE**, an ABS of a typical retail environment
- Showed that under a wide range of assumptions, improving job quality yields superior outcomes across typical corporate KPIs

Corporate Diversity, Equity & Inclusion





Clients

- Many companies

Challenge

- How to help executives understand the value of DEI and how to do it.

Approach

- Simulate a generic multi-level organization

Outcomes

- Determined that inclusion drives diversity and equity
- Invented a way to measure inclusion
- Matched industry data

Diversity

Equity

Inclusion

My definitions:

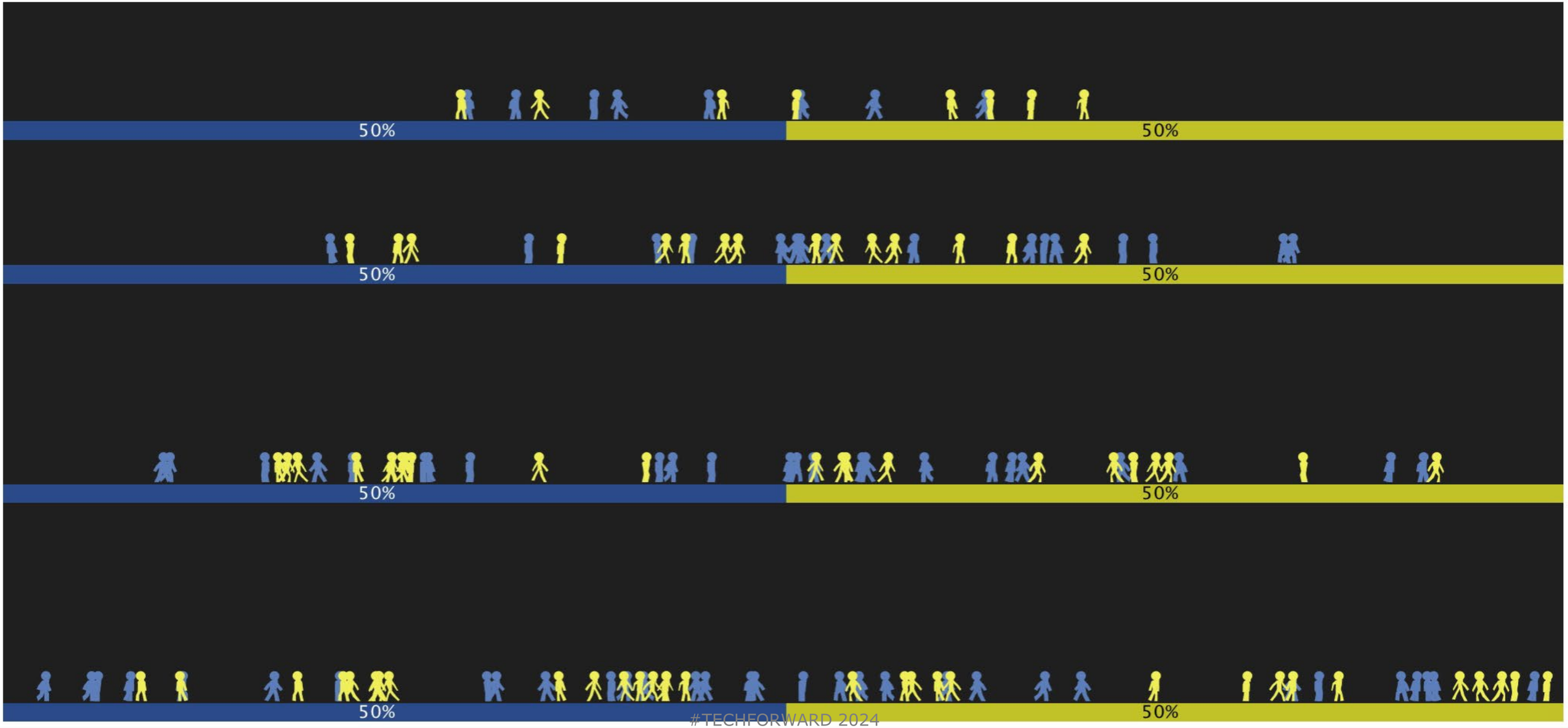
Inclusion is what you do

Diversity is what you get

Equity is what you want

INITIAL ASSUMPTIONS

Gender balance	Promotion bias?
Balanced	NO

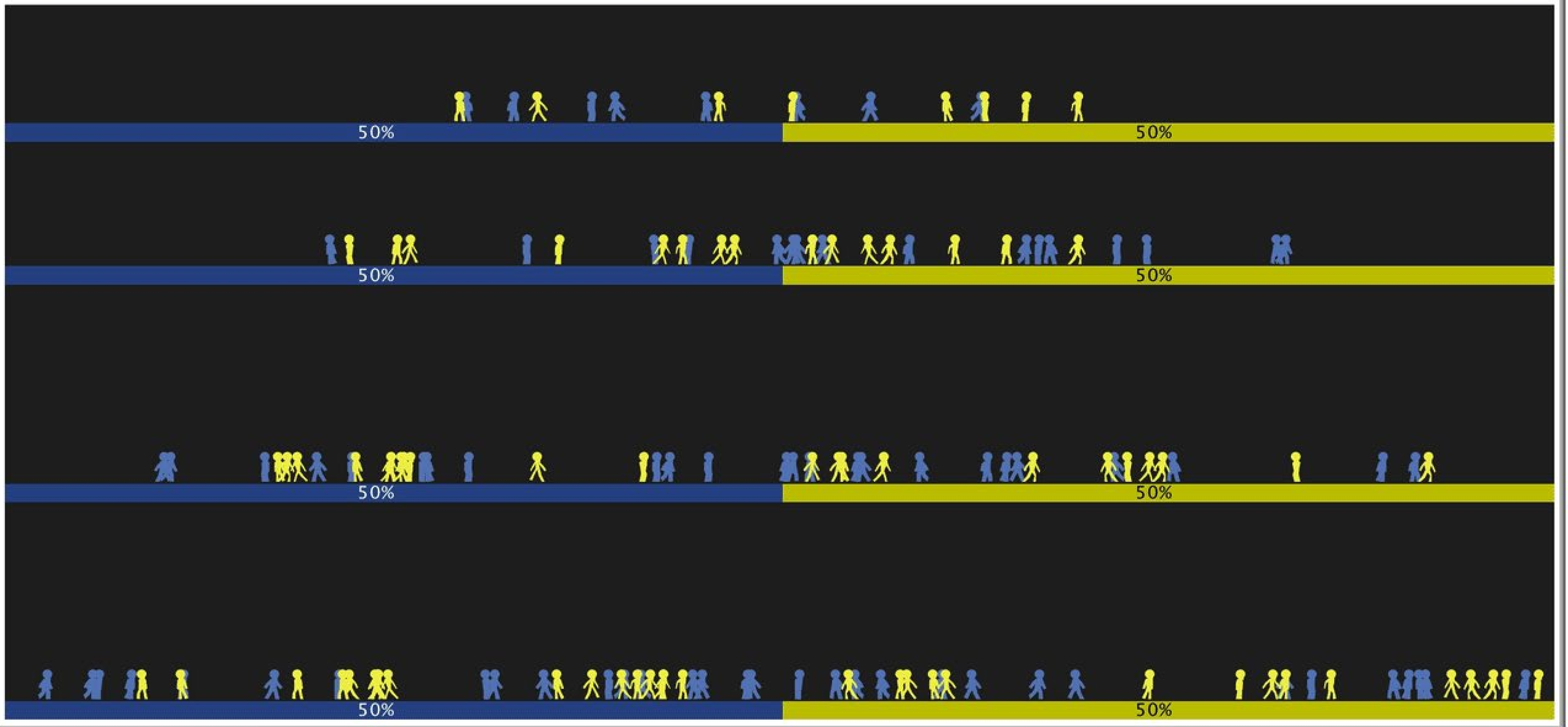


INITIAL ASSUMPTIONS

Gender balance	Promotion bias?
Balanced	NO

SIMULATON RESULTS

TIME	COMPANY TOTAL		HIRED		PROMOTED		SEPARATED	
Weeks	Men	Women	Men	Women	Men	Women	Men	Women
0	80	80	0	0	0	0	0	0

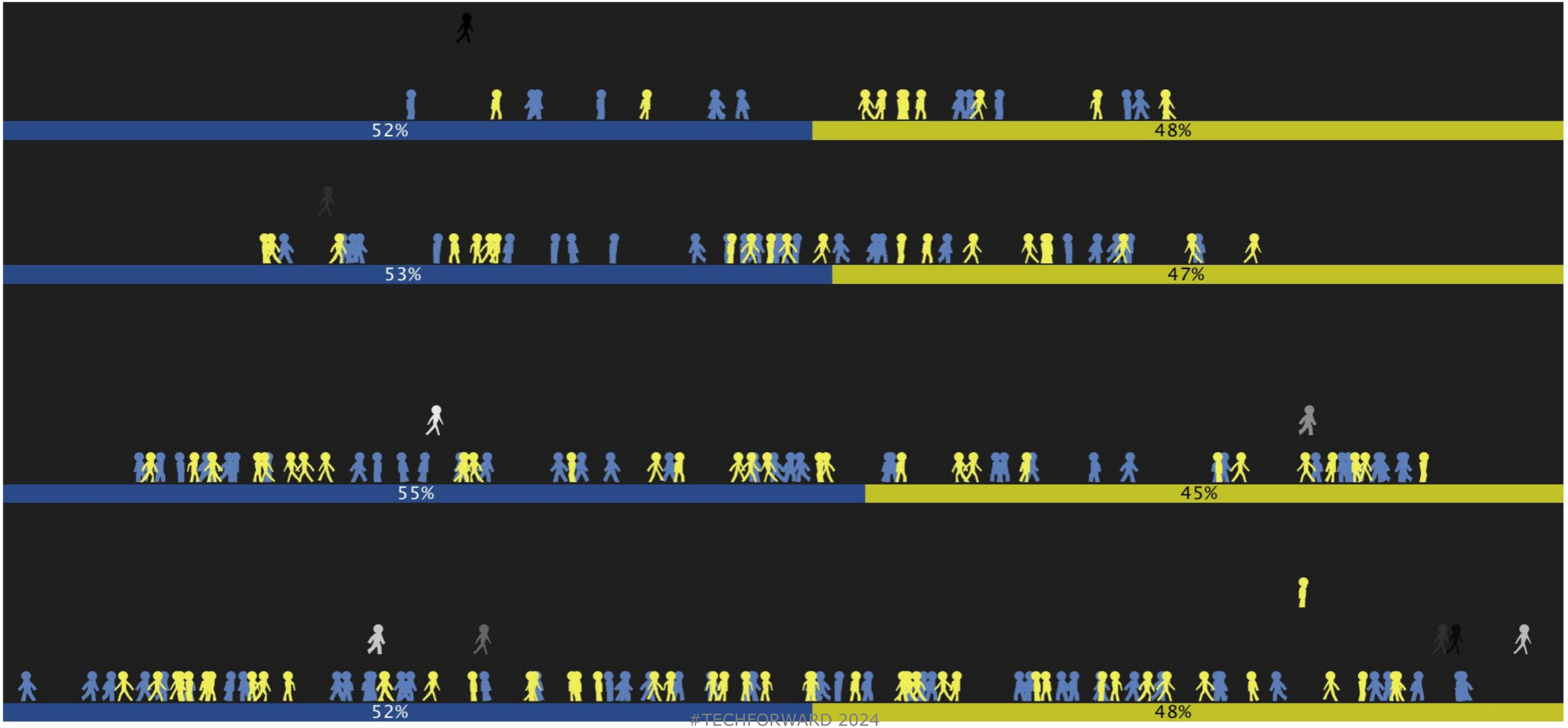


INITIAL ASSUMPTIONS

Gender balance	Promotion bias?
Balanced	NO

SIMULATON RESULTS

TIME	COMPANY TOTAL		HIRED		PROMOTED		SEPARATED	
Weeks	Men	Women	Men	Women	Men	Women	Men	Women
261	127	119	73	66	69	64	28	35



Introducing bias in the promotion process

INITIAL ASSUMPTIONS

Gender balance	Promotion bias?
Balanced	YES

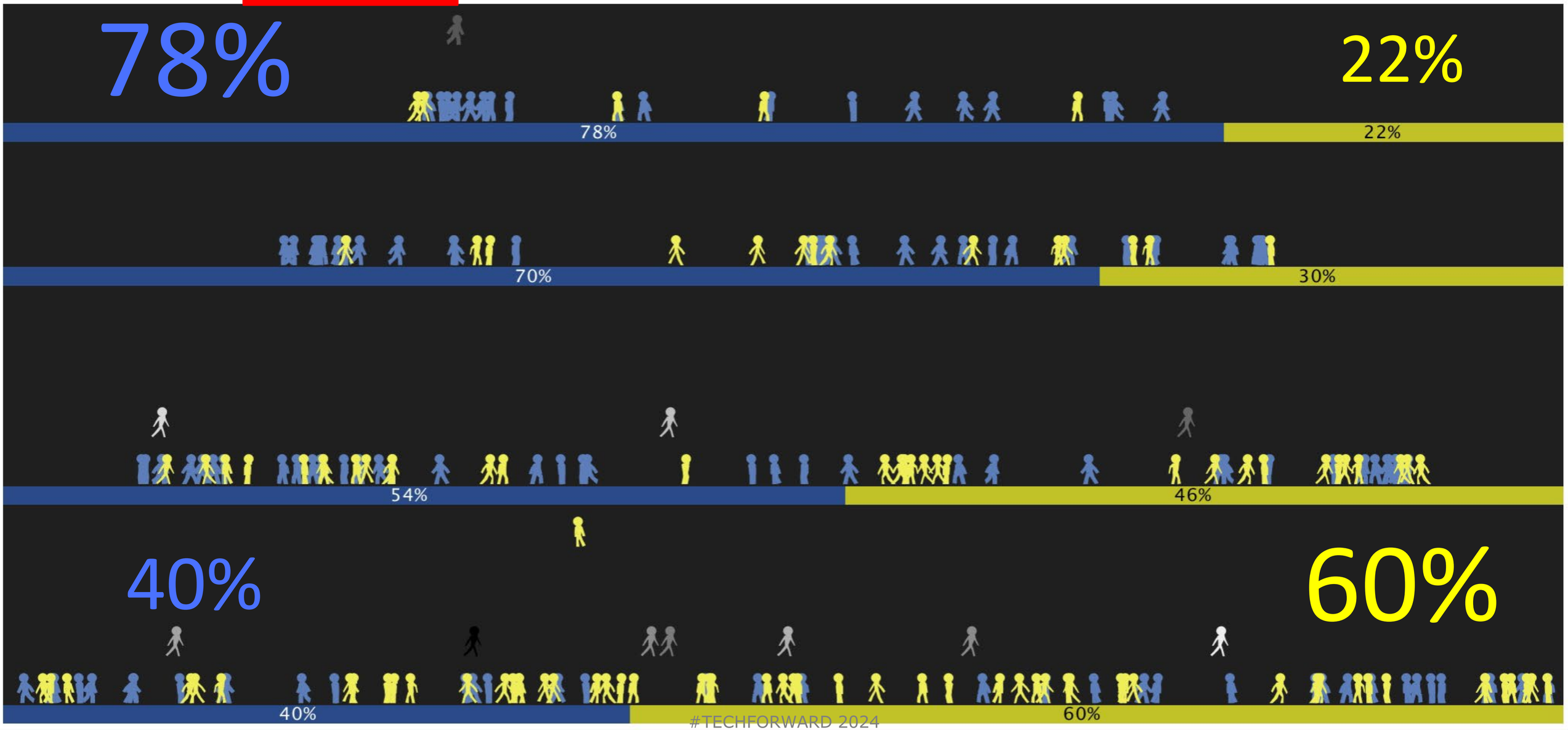
Start Balanced, Promotion Biases

INITIAL ASSUMPTIONS

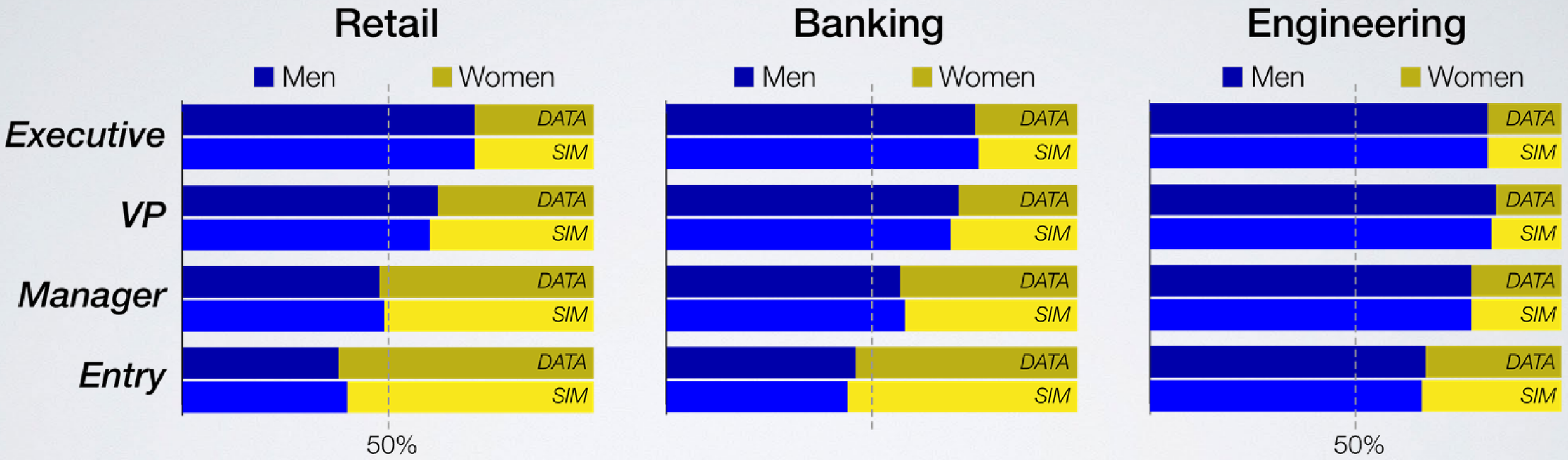
Gender balance	Promotion bias?
Balanced	YES

SIMULATON RESULTS

TIME	COMPANY TOTAL		HIRED		PROMOTED		SEPARATED	
Weeks	Men	Women	Men	Women	Men	Women	Men	Women
261	128	119	81	88	152	23	34	60



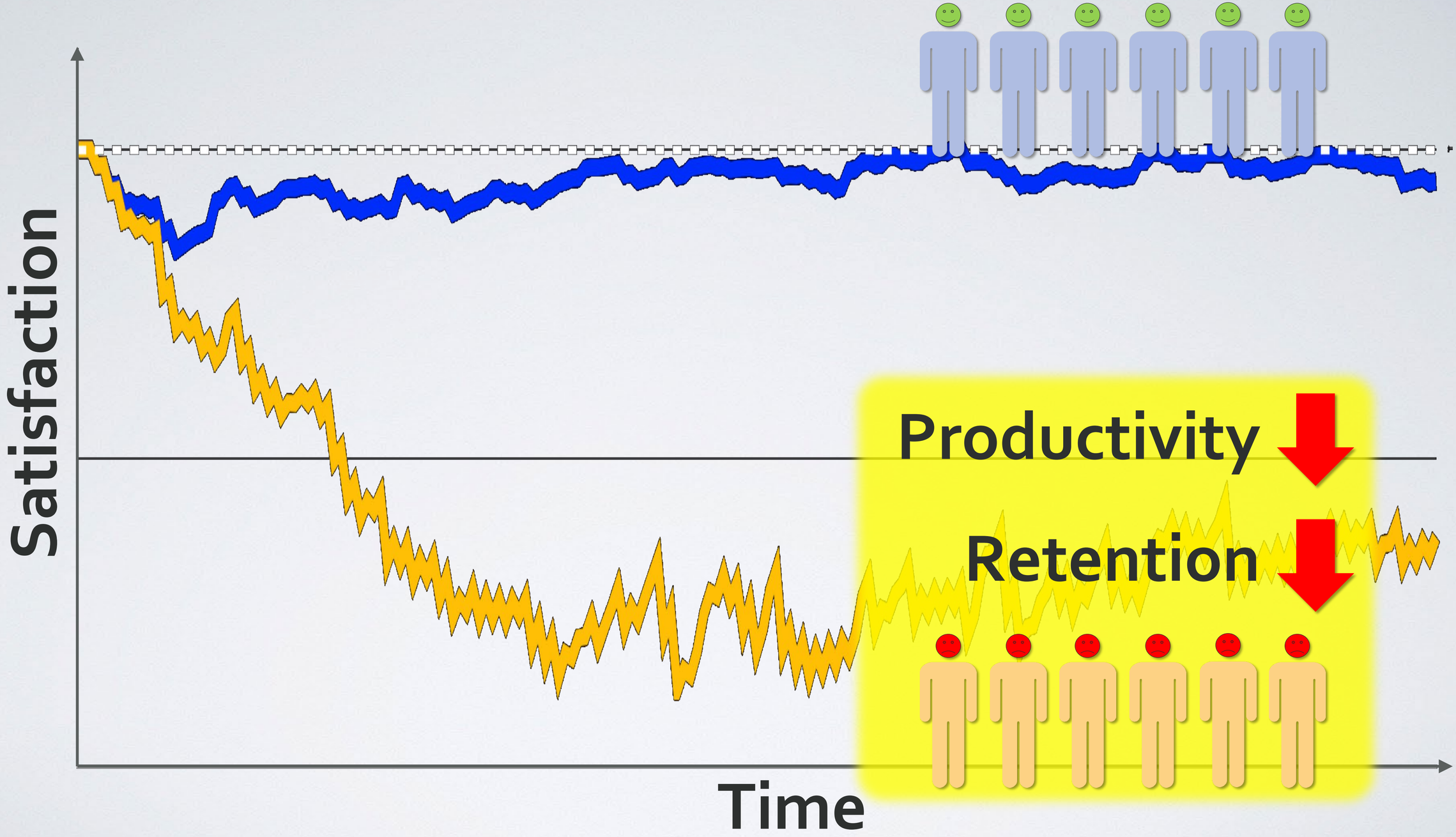
Inclusion is what you do
Diversity is what you get



Industry data source: McKinsey & Company: Women in the workplace, 2018

Simulation data: Zhang and Gaudiano, 2023

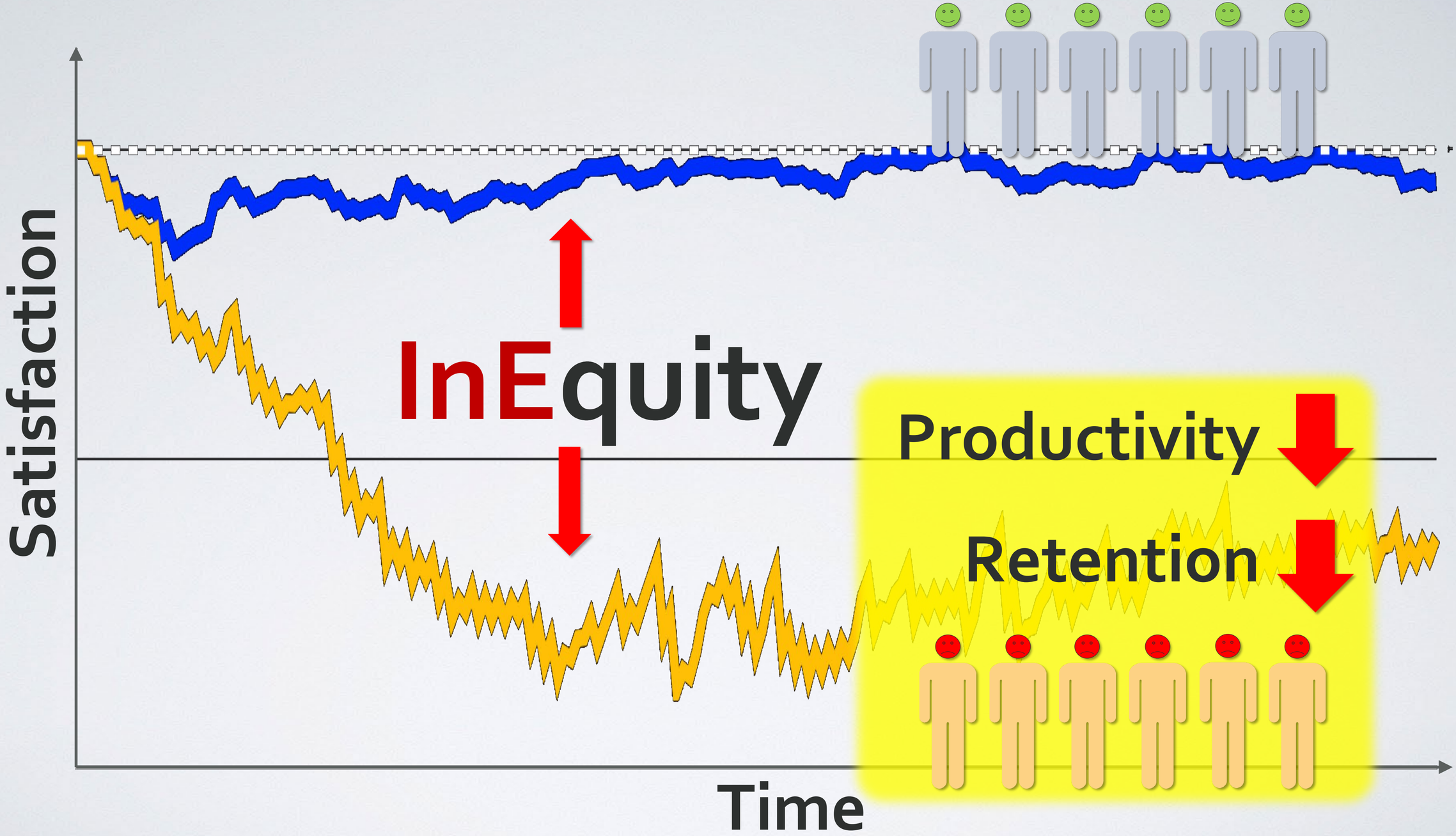
Inclusion drives performance


Satisfaction
Time
Productivity
Retention

Inclusion is what you do

Diversity is what you get

Equity is what you want

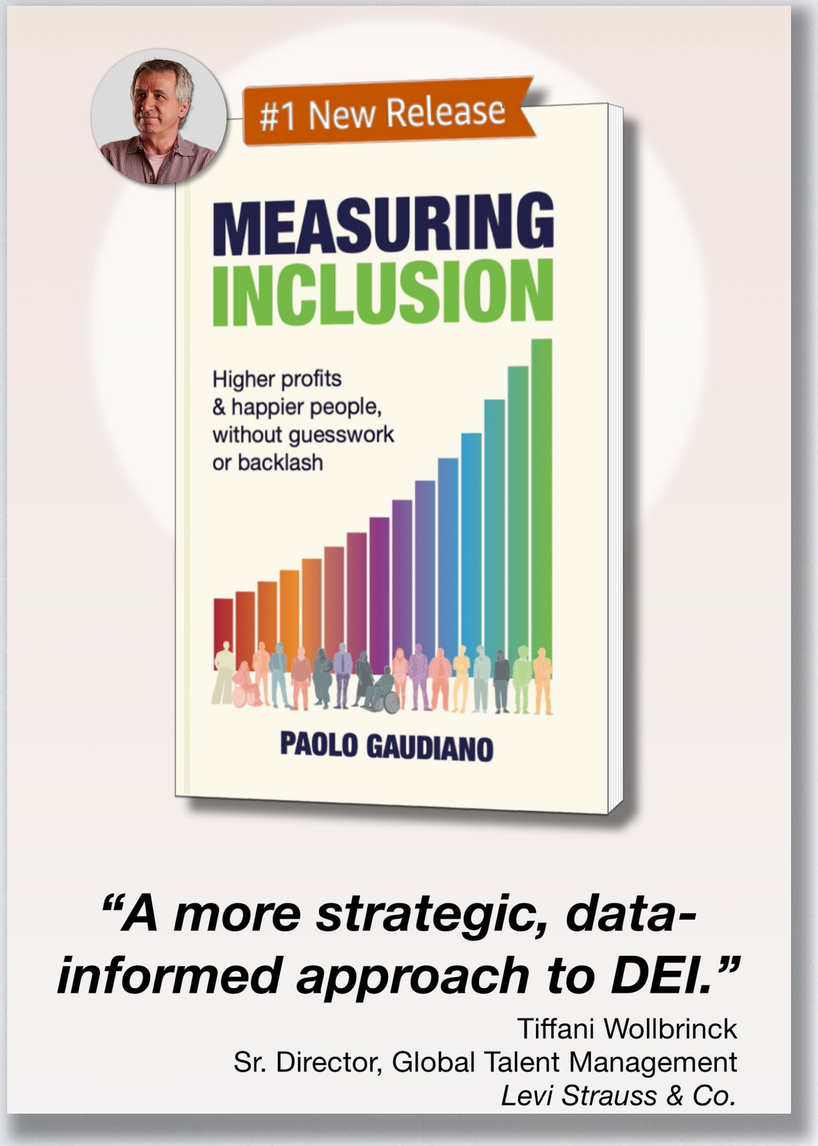

Satisfaction
InEquity
Productivity
Retention
Time

Wrapping up

Key take-aways

- Complexity is everywhere!
- Traditional analytical approaches don’t work well with complex systems
- Agent-based simulation is a powerful tool to analyze and manage complex systems

Check out my new book!



"A more strategic, data-informed approach to DEI."

Tiffani Wollbrinck
Sr. Director, Global Talent Management
Levi Strauss & Co.

Use code MIBOOK20