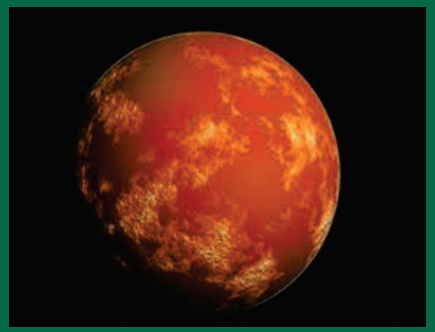
Leadership, Levels, & NASA: Mars Mission



Fran Yammarino

SUNY Distinguished Professor of Management

Director, Center for Leadership Studies

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Introduction

Initial NASA Proposal a Decade Ago: "Ahead of Its Time"; Technology & Aerospace First

NASA New Focus—Leadership & Collectives (incl. Teams & Networks) for Mars Mission

Phase I (Small Grant: OU Team & Me)—Literature Review, Interviews, and Models

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Introduction

Phase II (Large Grants: OU & BU Teams)

- Part A—Model Testing & Validation in Habitat, Lab Experiments, Interviews & Surveys, Content Coding of AARs (Historiometrics)
- Part B—Selection and Training of Crew

Overall Goals—There and Back Safe with Mars Mission Success

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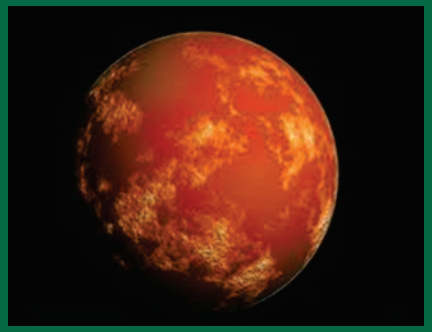
Setting & Situation

2.5-3 Year Trip to Mars (6-9 mos. there; 18 mos. on Mars; 6-9 mos. back)—Launch in ~15-20 years

Crew of 6-8 (8-10): Pilot, physician, geologist, biologist, mechanical engineer, electrical engineer; Combination of US (~2-4), Russia (~2), Europe, Canada, Japan;

Gender mix undefined (~2 females);

Currently in Elementary School!



Training likely 2.5 to 3.5 years+

NASA-Roscosmos Interactions

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Setting & Situation

Small Space:

Orion - 8.95 m^3 Surface habitat - 80 m^3
Crew Transfer Vehicle - 80 m^3

14.8 m^3/person max 1.5 m^3/person min

Some assembly & launch from Space Station (ISS) and/or "sling-shot"

Pre-launch supplies, fuel, habitat (for 6-10) and sub-habitat (for 2 with 1-2 week sorties, 6-8 sorties)

[Game changer: "pulse/plasma/nuclear" Orion rocket—16-18 crew and 36-day trip one way!]

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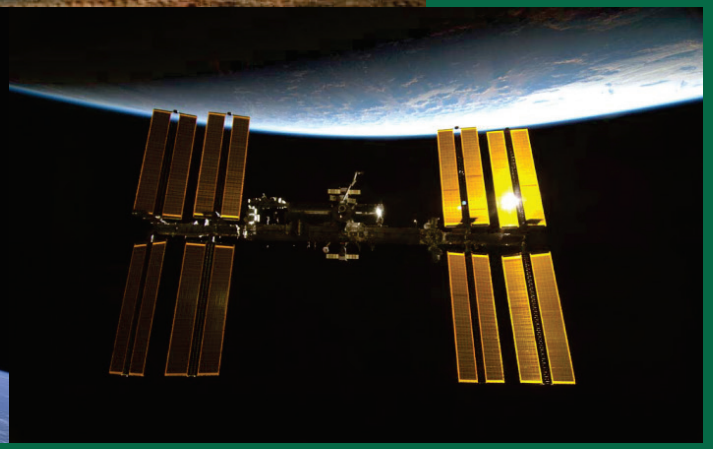
Setting & Situation



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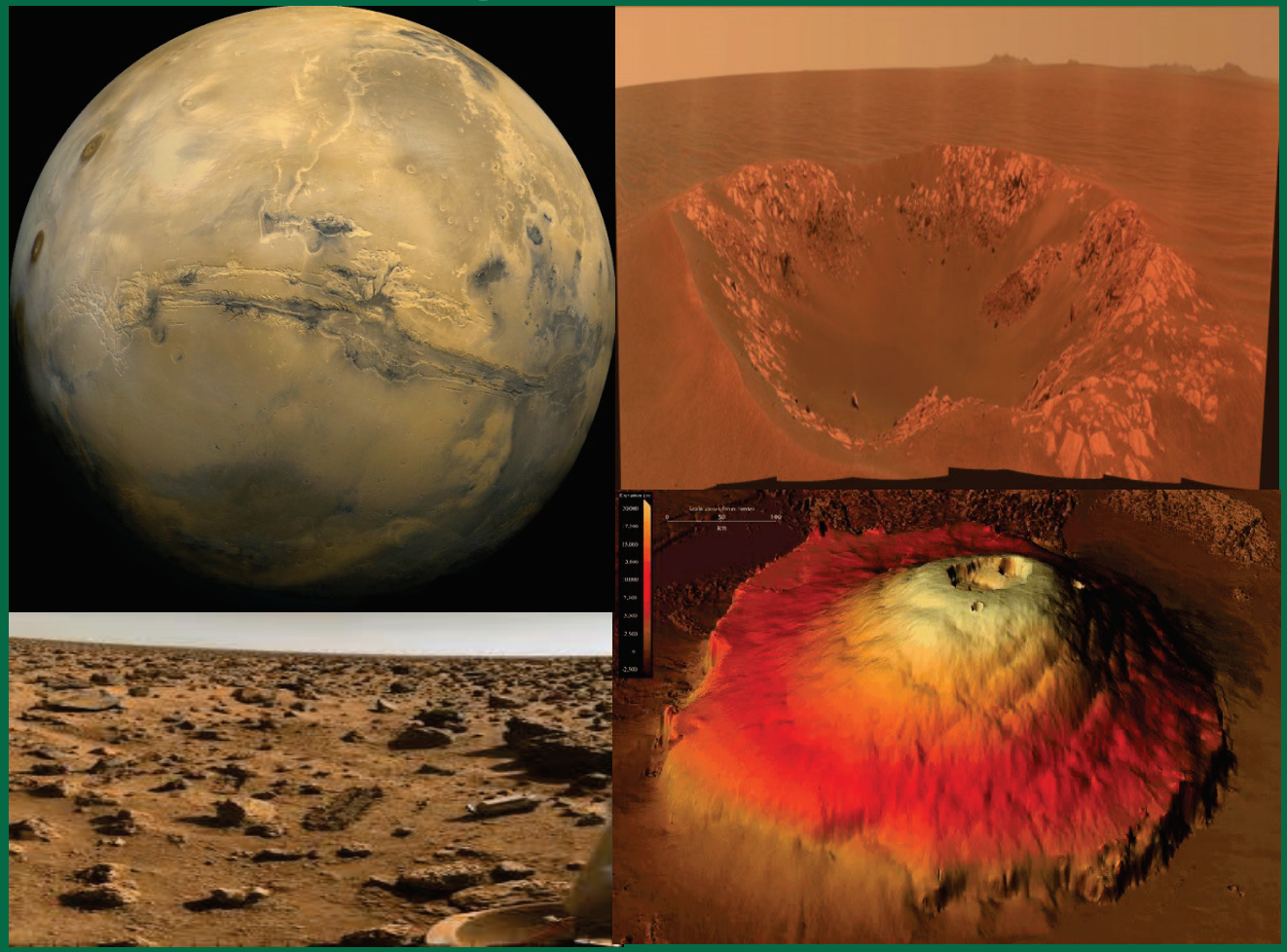
Setting & Situation



NASA
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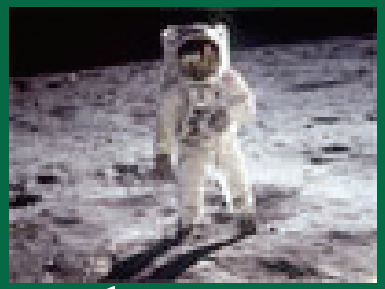
Setting & Situation

NASA Human Research Program



Investigates and mitigates the highest risks to human health and performance

Provides essential countermeasures and technologies for human space exploration

Risks include physiological effects from radiation, hypogravity, and terrestrial environments; and unique challenges in medical support, human factors, and behavioral health support

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Setting & Situation

NASA Human Research Roadmap Risk:

- "Human Performance Failure Because of Poor Psychosocial Adaptation"
- "High Likelihood, High Consequence Risks with Low Risk Mitigation Status"

Need for Research on "Psychosocial Issues in Space"

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Setting & Situation

Very Dangerous, High-Pressure & Dynamic, Boredom & High Stress, Small Space

22 minutes Communication (audio & video) Delay (one-way) minimum but up to 7 days

3-4 times more dangerous & hostile than Antarctica

Radiation Exposure:~1-2 millisieverts/day (~1000 msv total): same daily rate but 5 times total for 12 mos. on ISS (Genetic screening in crew selection?)

8 High Activity times (Launch, Jettison Tanks, Arrival, Undock Orion, Dock to Habitat Lander, Landing, Launch, Dock to Crew Transfer Vehicle, Landing)

Likely High Autonomy from Ground and Vehicle

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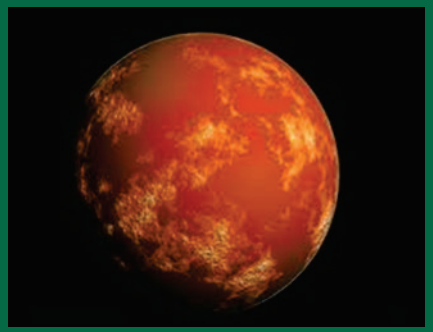
Setting & Situation

Space: Extreme & Dangerous Environment

Analogue Environments:



- Antarctica (& Hawaii) Habitats
- Arctic Expeditions
- Submarine Crews
- Special Forces Operations*
- First Responders in Natural Disasters & Crises
- Space Habitat Studies on Earth
- Mir, Skylab, Space Station, Apollo Moon Missions

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Prior Research

Analogue & Extreme Environments

- Leadership is difficult and demanding
- Team Dynamics are strained with conflicts and miscommunications
- Individual and Team Performance suffer; KSAs decline

Based on Traditional Models 1940s-1970s from Clinical Psych, Anthropology, & Sociology

Lacked Multi-Level Aspects and Work from I/O Psych & OB

Missed Key Aspects of Leadership, Interpersonal Relationships, and Team/Crew Dynamics

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Current Research

- Focus on the "Real Environment"
- Use Theories/Models from 1990's +
- Foundations in OB (Management) and I/O (and Social) Psychology but include All Fields & Environments
- Include Multiple and Integrative Aspects of Leadership and Team Dynamics

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Interview Quotes

*"The astronauts are just doing the flight director's mission. They are merely an extension of the ground control. Astronauts are 'tip of the spear.' This has been the mentality of NASA for 50 years but this will have to change for Mars."**

Behavioral Health and Performance Personnel

"NASA has spent the last 30 years breeding out leadership and breeding in management. Every leadership course I ever took was actually management training. As a result, NASA ended up with a lot of ineffective leaders at high level positions."

Former Flight Director

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Potential Model/Conceptualization

Leadership and Team Dynamics are both Context-Dependent and Multi-Level in Nature

Given the Context of Long-Term Space Flight, Leadership and Team Dynamics must address:

- Crews of Scientists & Engineers
- Ind., Dyadic (e.g., sorties), Team Perfm. & Collective (e.g., Crew-MC, US-Russia) Efforts
- Crises (Major & Minor) & Crisis Mgmt.
- Cognitive but also Socio-Emotional Issues

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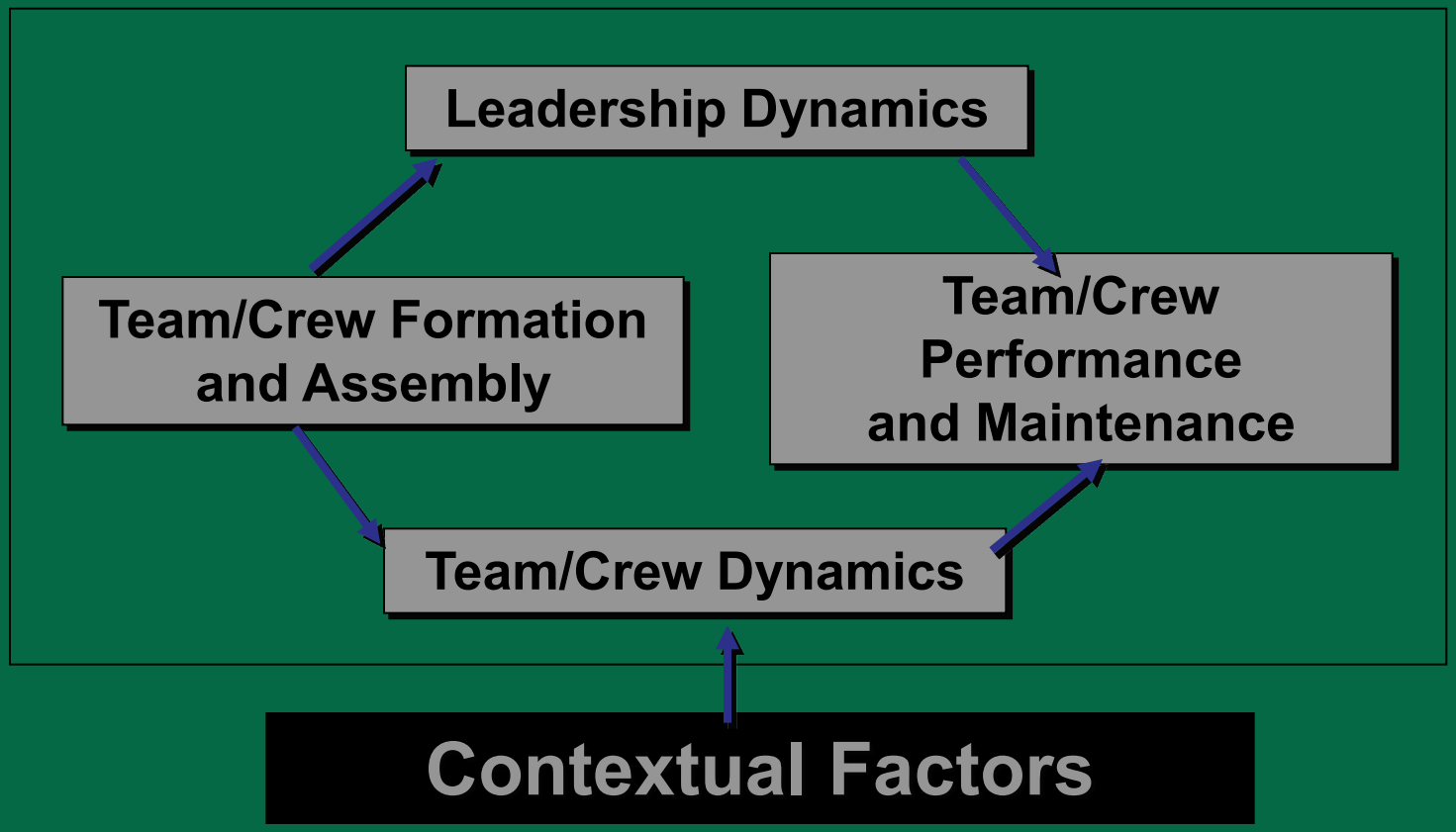
Leadership and Team Dynamics for Long-Term Space Flight



Preliminary & Advanced Models

One Model of Context of Long-Term Space Flight and Multi-Level Leadership and Team Dynamics:

- Pragmatic & Crisis at Individual Level
- Individualized & Dyadic at Dyad Level
- Shared & Socio-Emotion at Team/Crew Level
- Collectivistic & Collective at Collective Level
- Integrated & Role Switching via Multiple Levels of Analysis

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Pragmatic Leadership

- Practical or Functional Problem-Solving
- Focus on the Present
- KSA's for Solving Complex Social Problems: Knowledge, Perspective-Taking, Creativity, Social Judgment, Planning
- Individual Differences in Leaders' Styles
- Individual Level of Analysis

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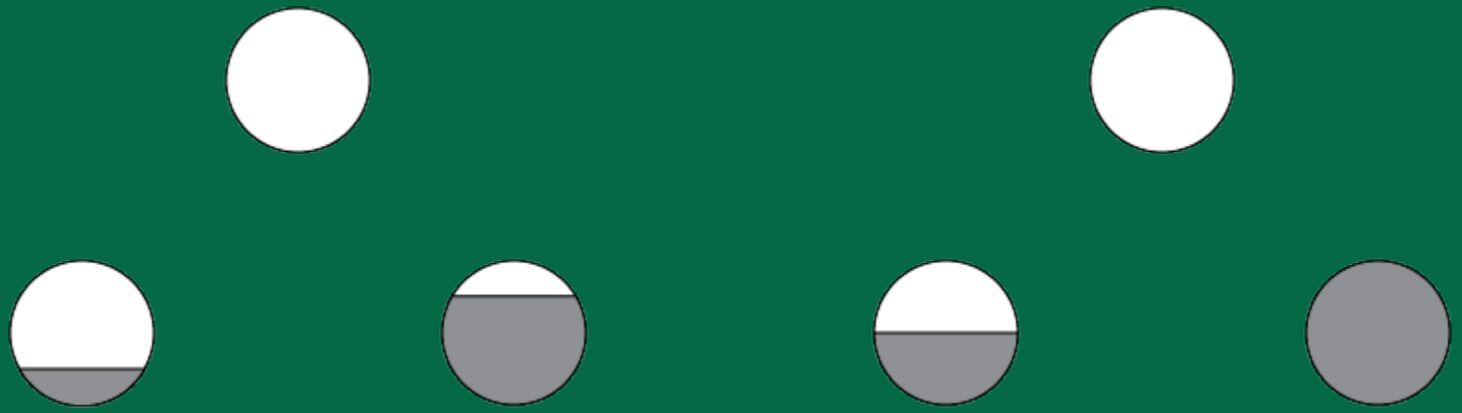
Individuals



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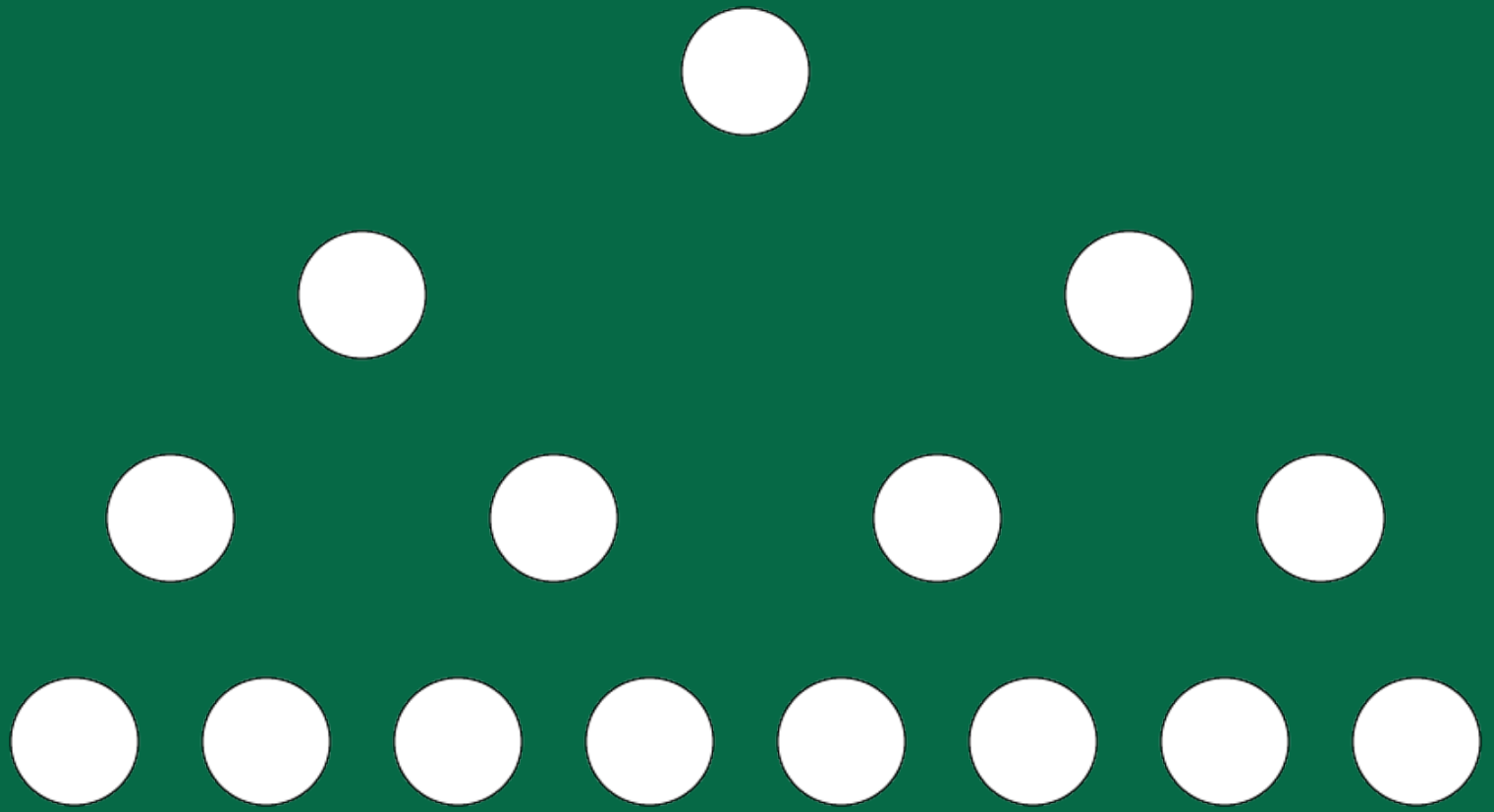
Organization of Individuals



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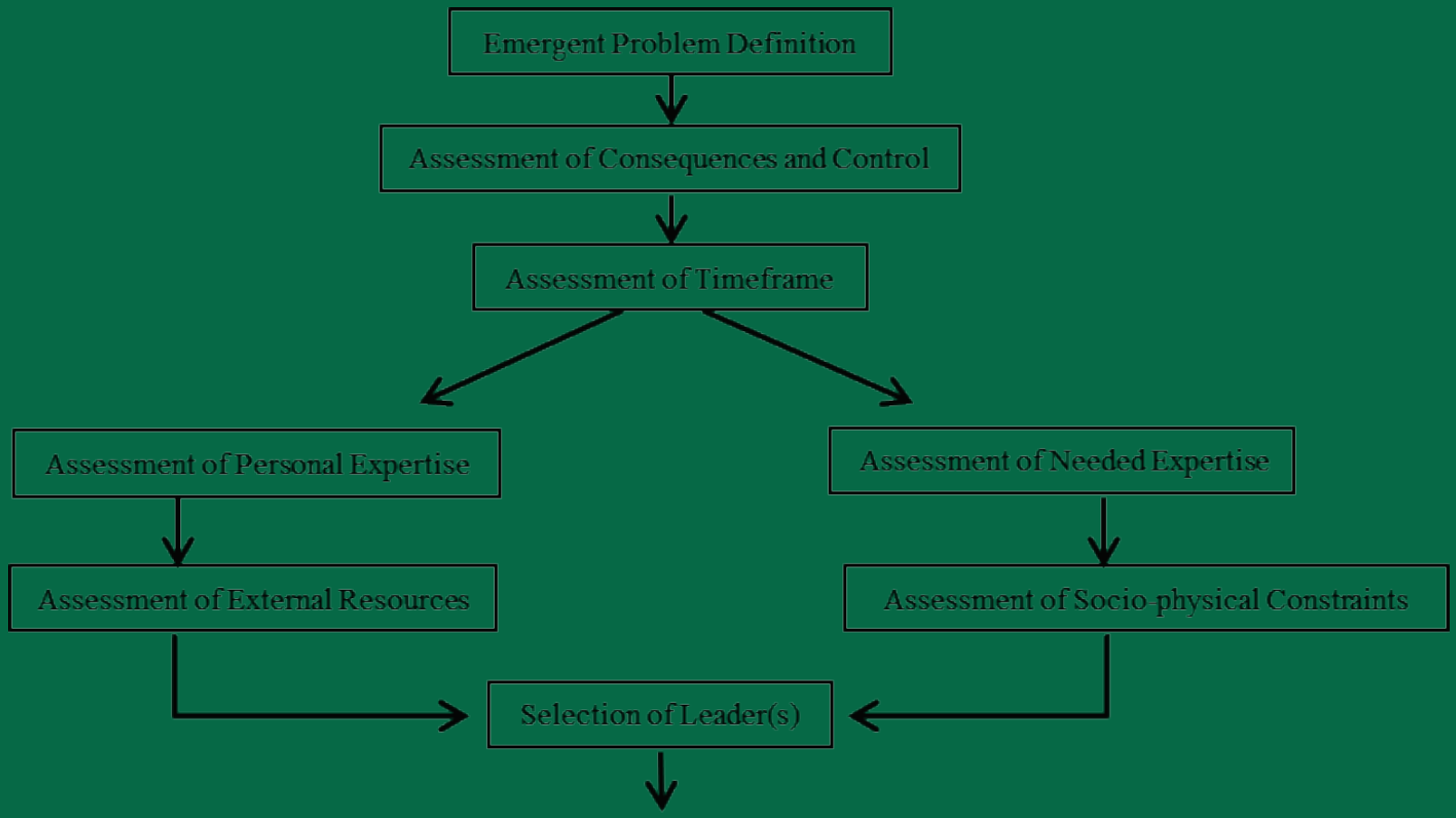
Crisis Model: Selection of Leaders



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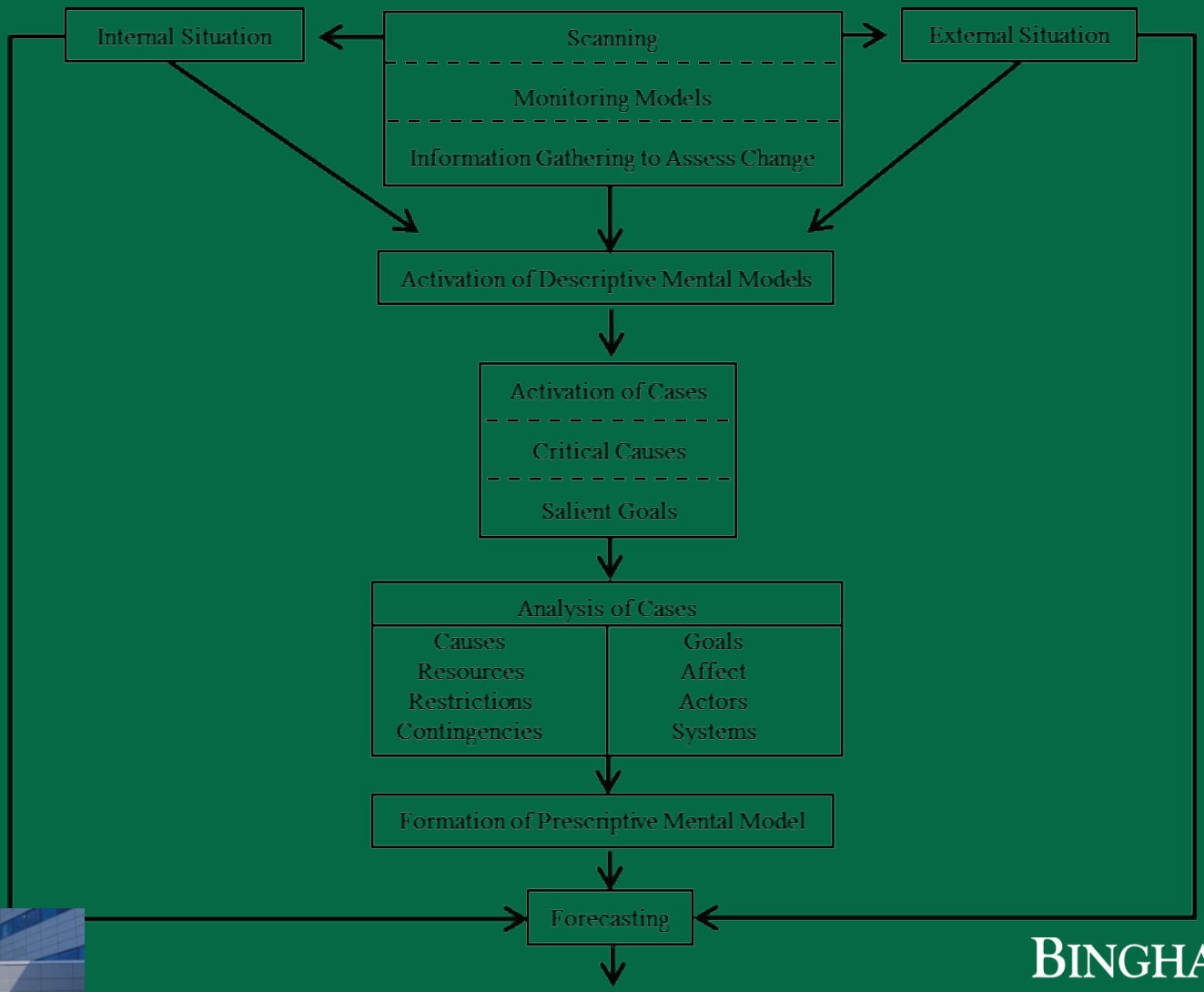
Crisis Model: Sensemaking



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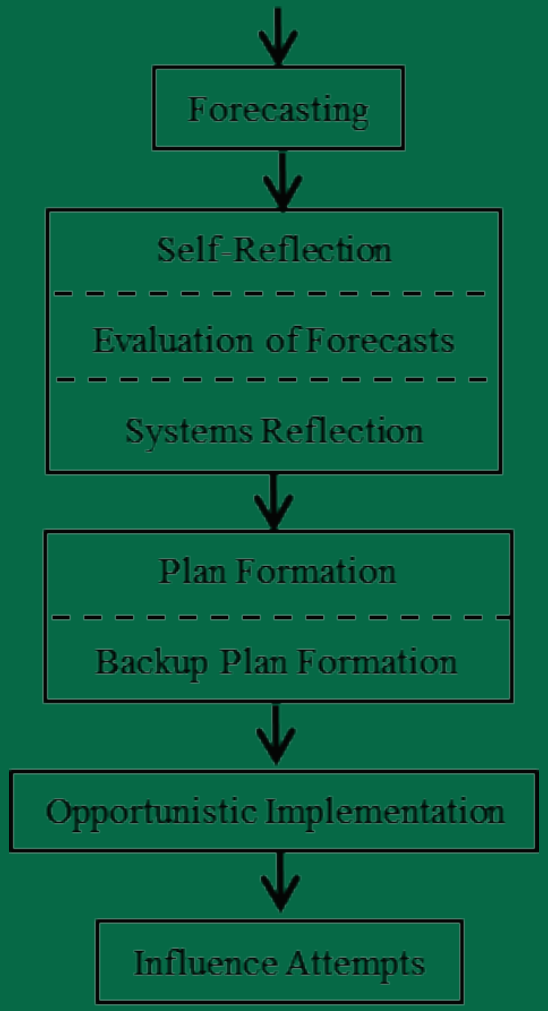
Crisis Model: Forecasting and Planning



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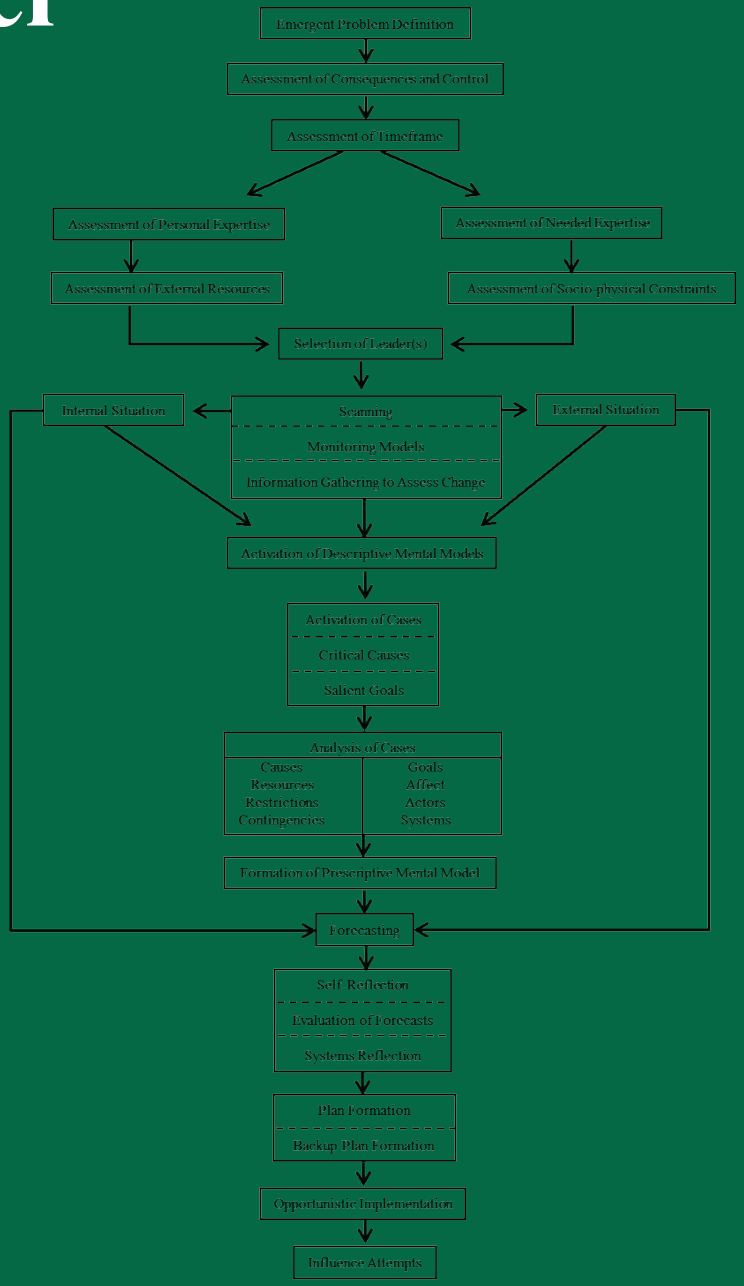
Crisis Model



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Crisis: Interview Support

"We don't currently have an Ops concept that works for Mars, as the crew will need to be more autonomous. But, we do know that the flight control team has hundreds of years of experience when you add them all up whereas the crew has much less experience. The knowledge depth here will be really critical."

Psychological Operations, Behavioral Health and Performance

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Individualized Leadership

- Investments and Returns by Superiors and Subordinates or Peers
- Support for Self-Worth and Satisfying Performance
- Interpersonal (1-to-1) Relationships in Balance and "Rich"
- Dyad Level of Analysis

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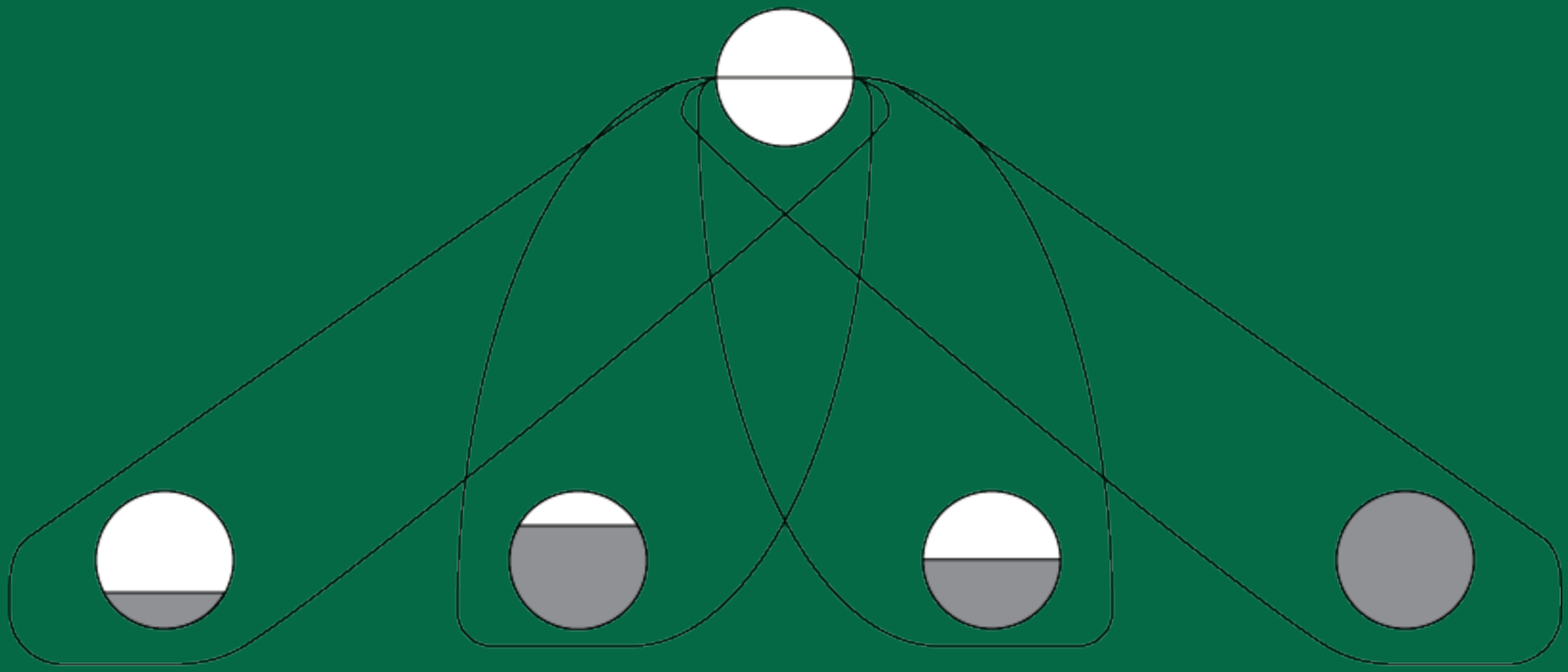
Dyads



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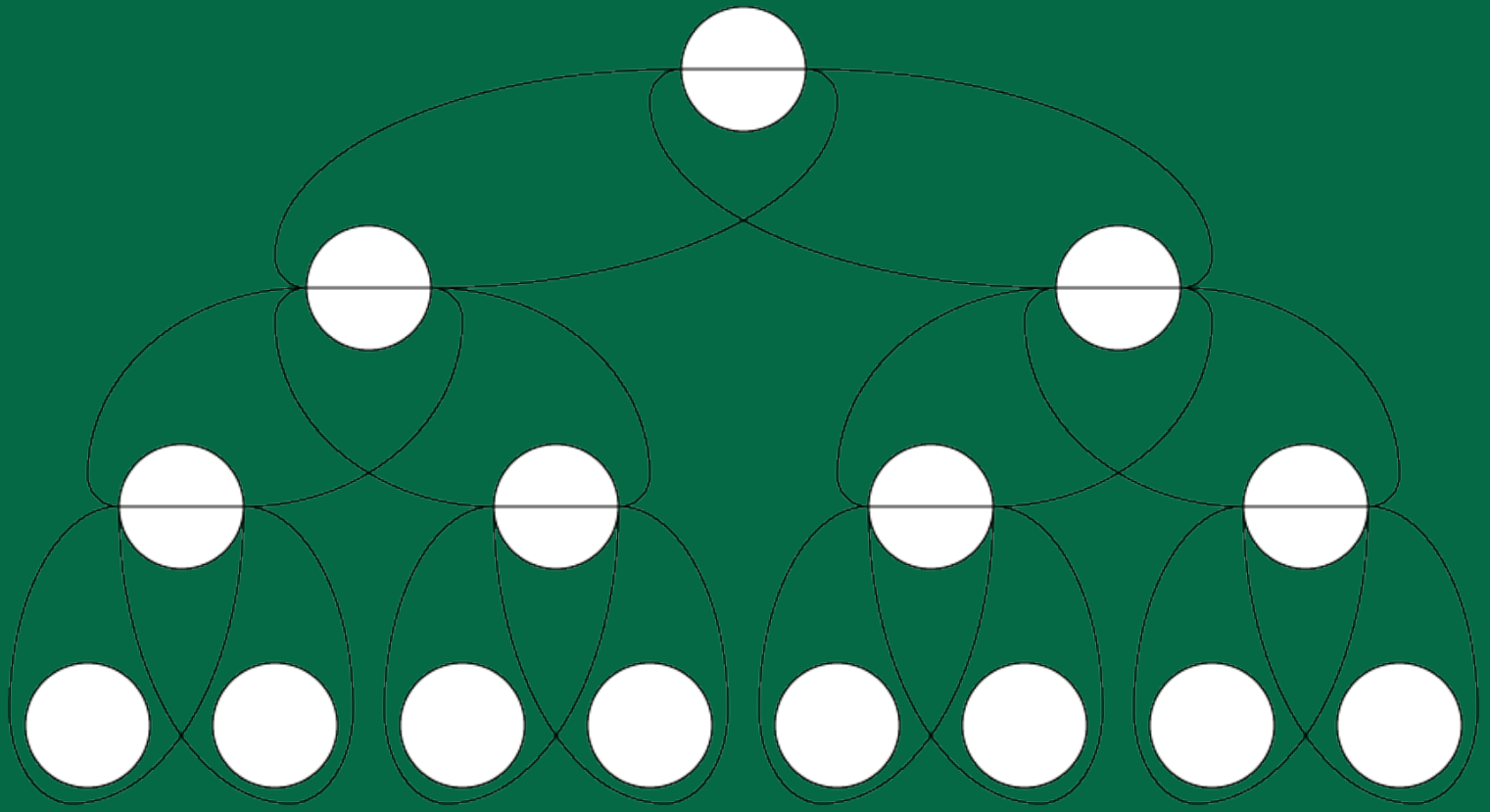
Organization of Dyads



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Dyadic Model

Dyad Level
- Similarity
  - Affect
  - Belief
  - Needs
  - Values
  - Need for Achievement
  - Autonomy
  - Recognition of Another
- Attraction and Mutual Liking
- Trust
- Mutual Respect
- Interdependence
  - Task Interdependence
  - Outcome Interdependence
- Psychological Distance
- Physical Distance
- Formality of Exchanges
- Empowerment

Situational Moderators

Nature of Tasks and Roles
Standard Operating Procedures and Policies
Multiple Goals and Constituencies
Resource Constraints
Political Agendas
Structural Interdependence
- Features of the Work
- How Goals are Defined
- How Rewards are Distributed

Individual Level (Leader & Follower)
- Superior's Accountability or Experience
- Feelings of Safety
  - No Personal Risk
  - Openness
  - Perceived Common Interests
  - No Threats
- Autonomy Preference
- Commitment to Success
- Self-efficacy
- Inspiration To Do Best
- Positive Feedback
- Trust

Outcomes (Mostly Derived From Theory)
- Satisfying Performance
- Objective Performance
- Support for Self-Worth
- Long-Term Interpersonal Relationships
- Promotions or Opportunities for Advancement
  - Not Necessarily Hierarchical
- Quality of Performance
- Morale
- Communication
- Delegation
- High-Quality LMX
- Cooperation

Dyadic: Interview Support

"If missions always went as planned, it wouldn't make a difference. When things go bad, trust is needed. I really think trust is crucial…Being able to ensure trust is present throughout the duration of a mission is critical. "

Former Flight Director, Mission Control

"The most effective commanders that I have known have all ensured that every member of the crew had ownership of some significant aspect of the mission…Everybody had some significant role to play in the mission…"

Former Astronaut

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Shared Leadership

- Shared Mental Models
- Shared Knowledge, Information, and Cognitions
- Cross-Functional and Multi-Functional Skills
- Role Shifting
- Team Dynamics and "Teamwork"
- Team/Group Level of Analysis

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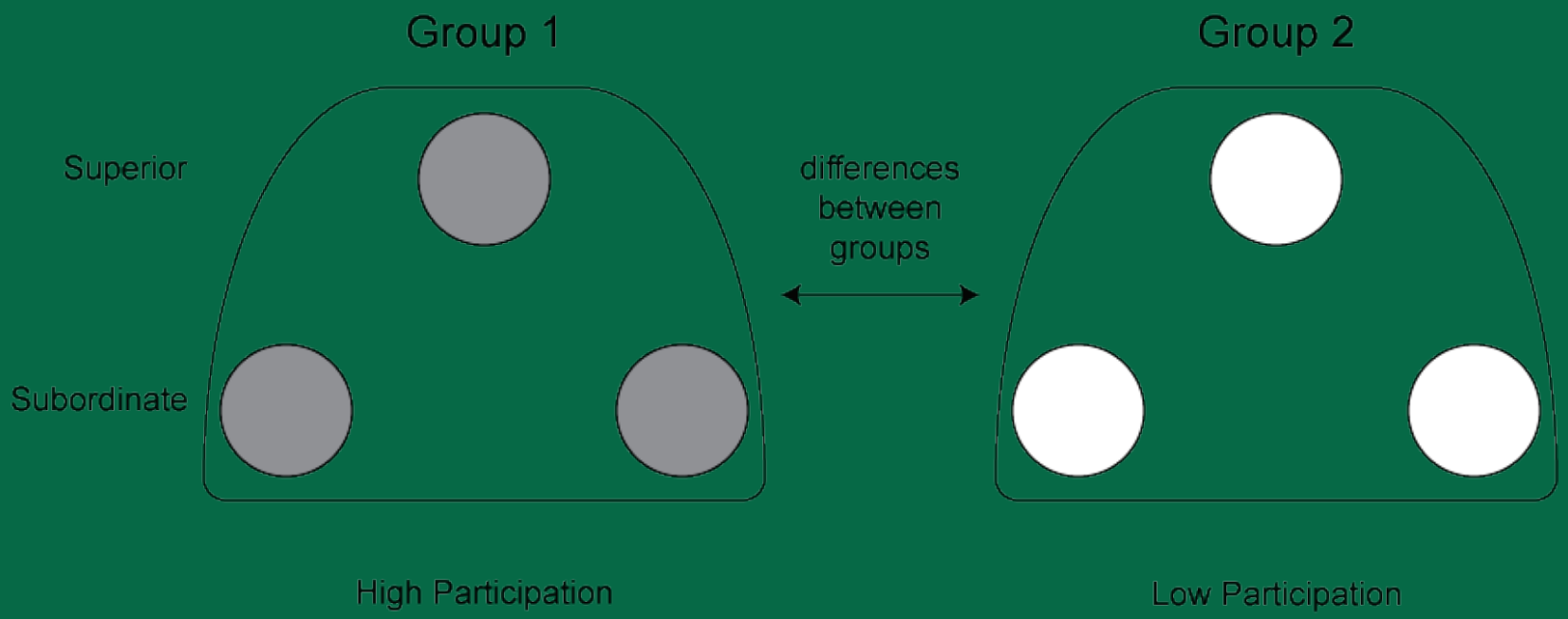
Homogeneous Groups



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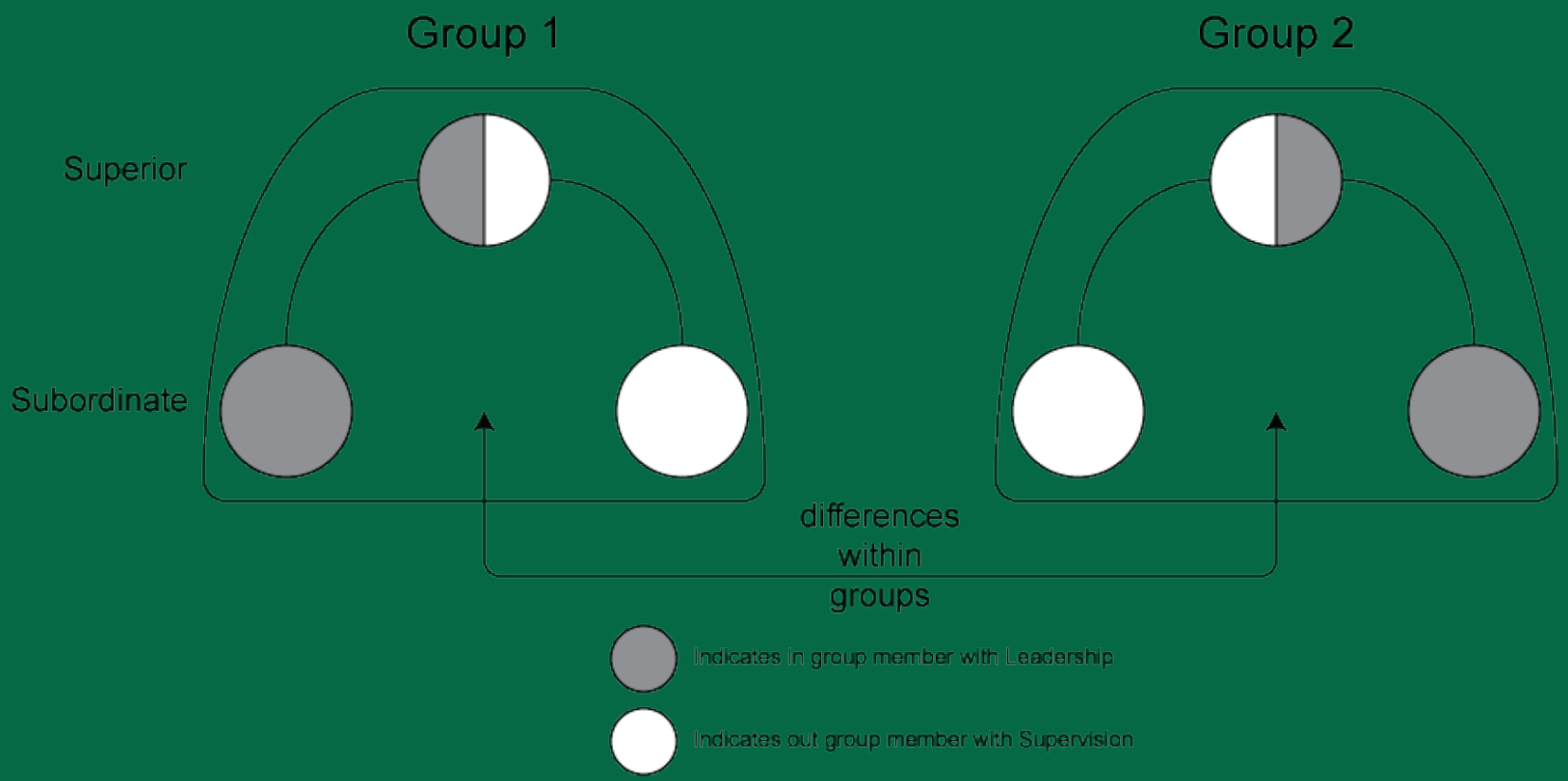
Heterogeneous Groups



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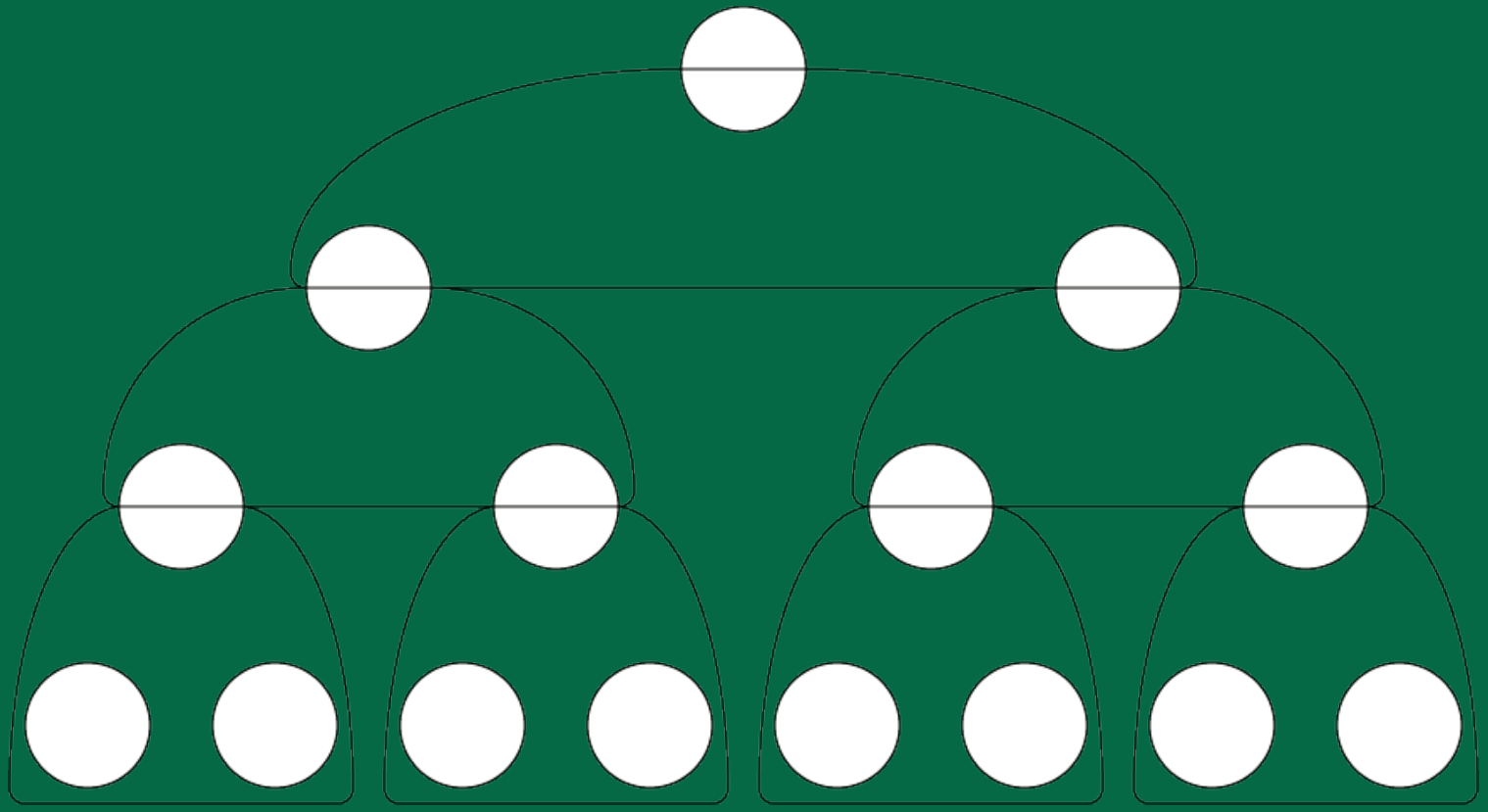
Organization of Groups



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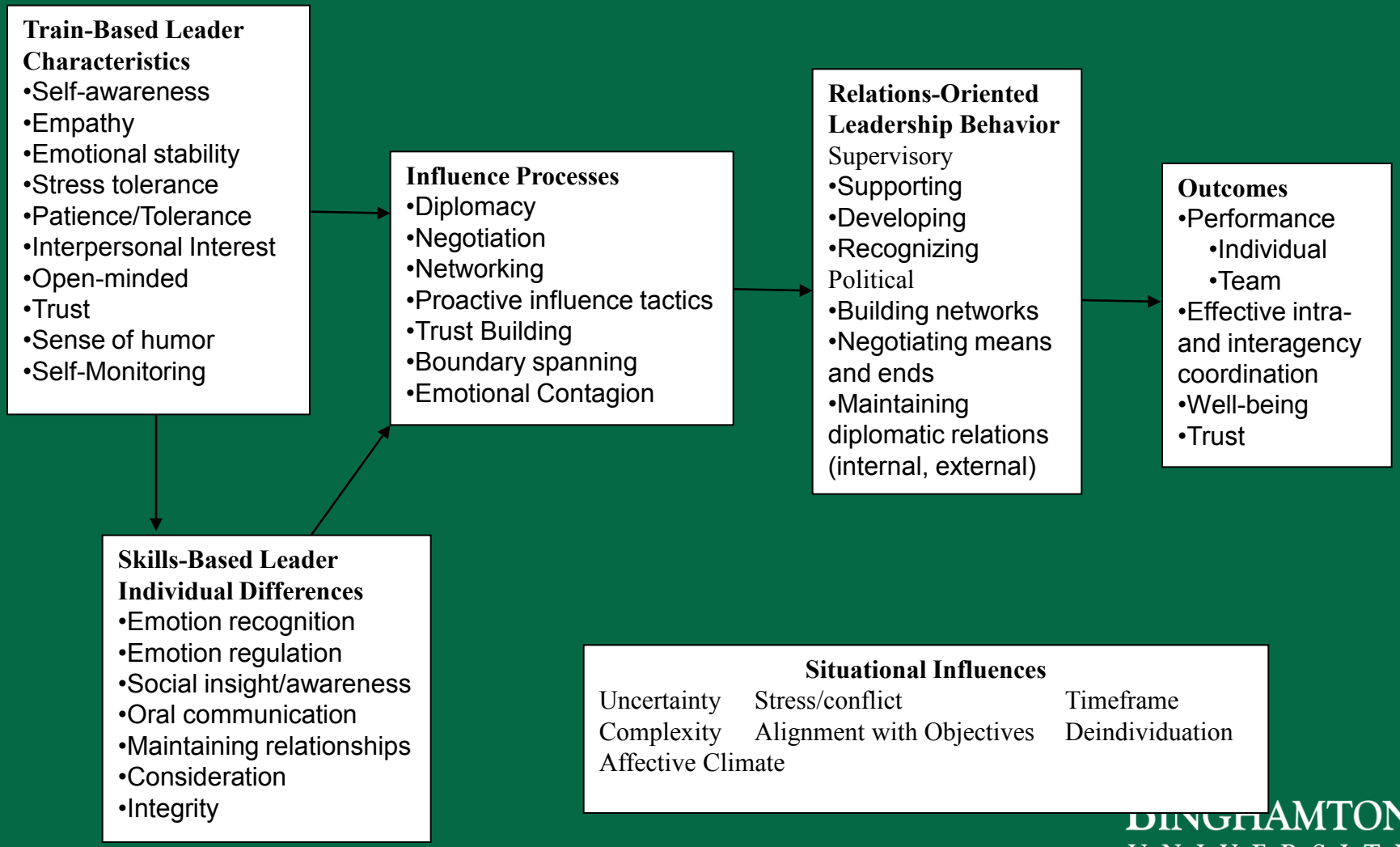
Socio-Emotional Model



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Socio-Emotional: Interview Support

"The most effective crew commanders that I have seen have made everyone feel that they were the most important person on the team. You need to be interested in what the person has to say. You need to be engaged and understand big picture…. You can't have military mindset. You need to be involved with folks at every level."

Former Flight Director

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Collectivistic Leadership

Dynamic Multi-Level Process

Leader(s) selectively utilize Skills of Others

Leader(s) distribute elements of Leadership Role among Others as Situation demands

Involves use of Networks (formal & informal)

Crew-Mission Control Interface

Collective Level of Analysis

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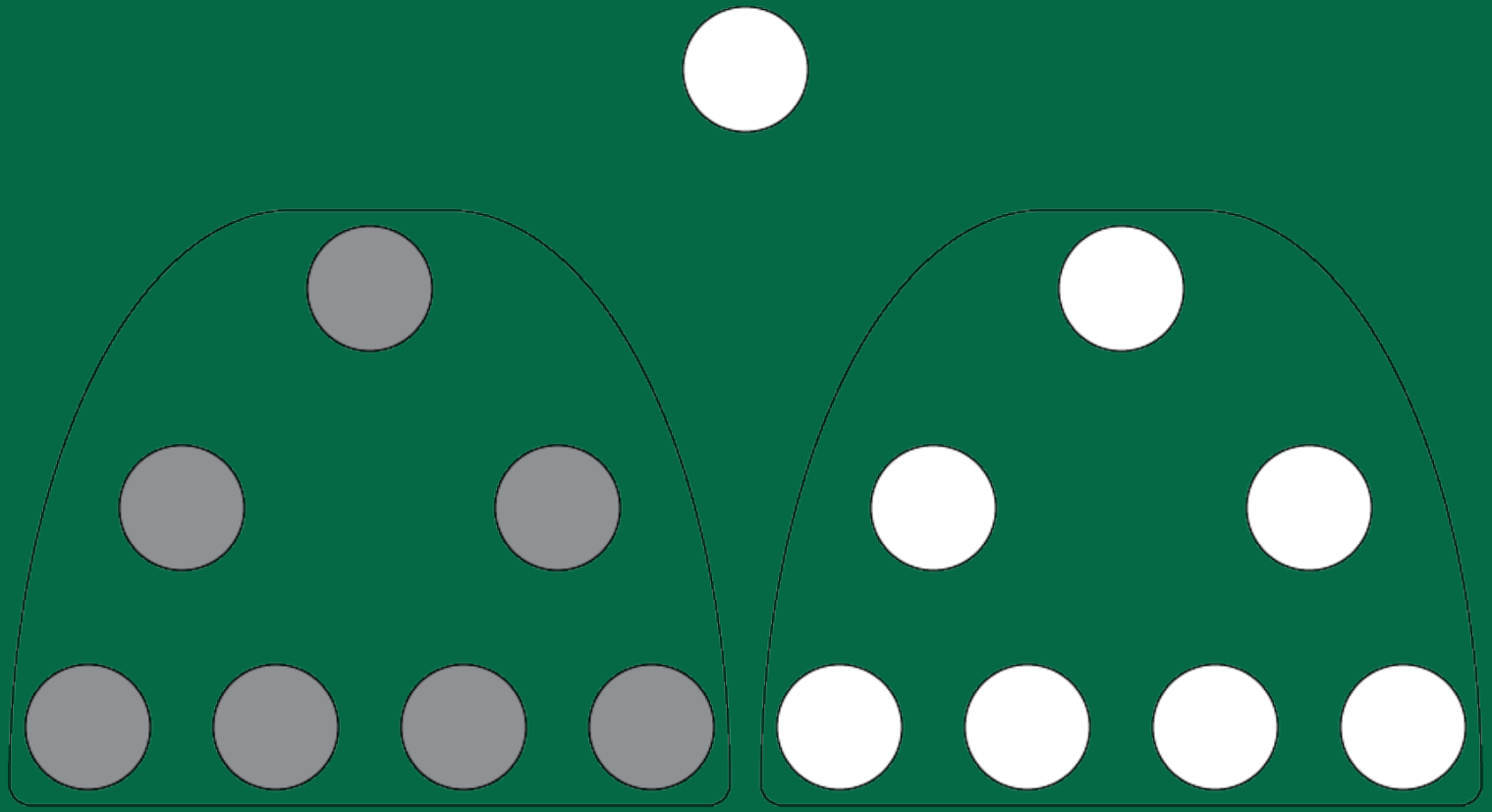
Collectives



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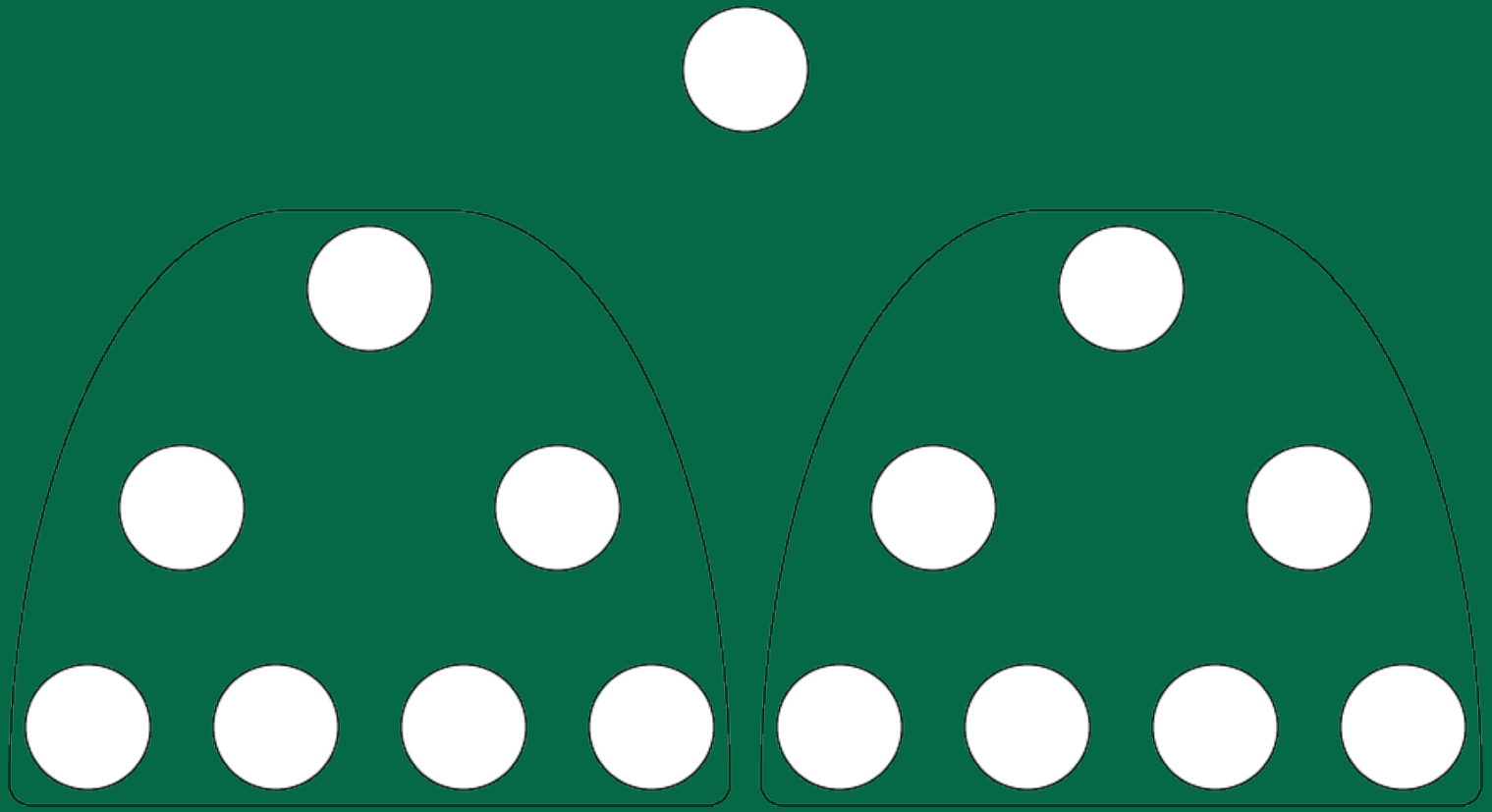
Organization of Collectives



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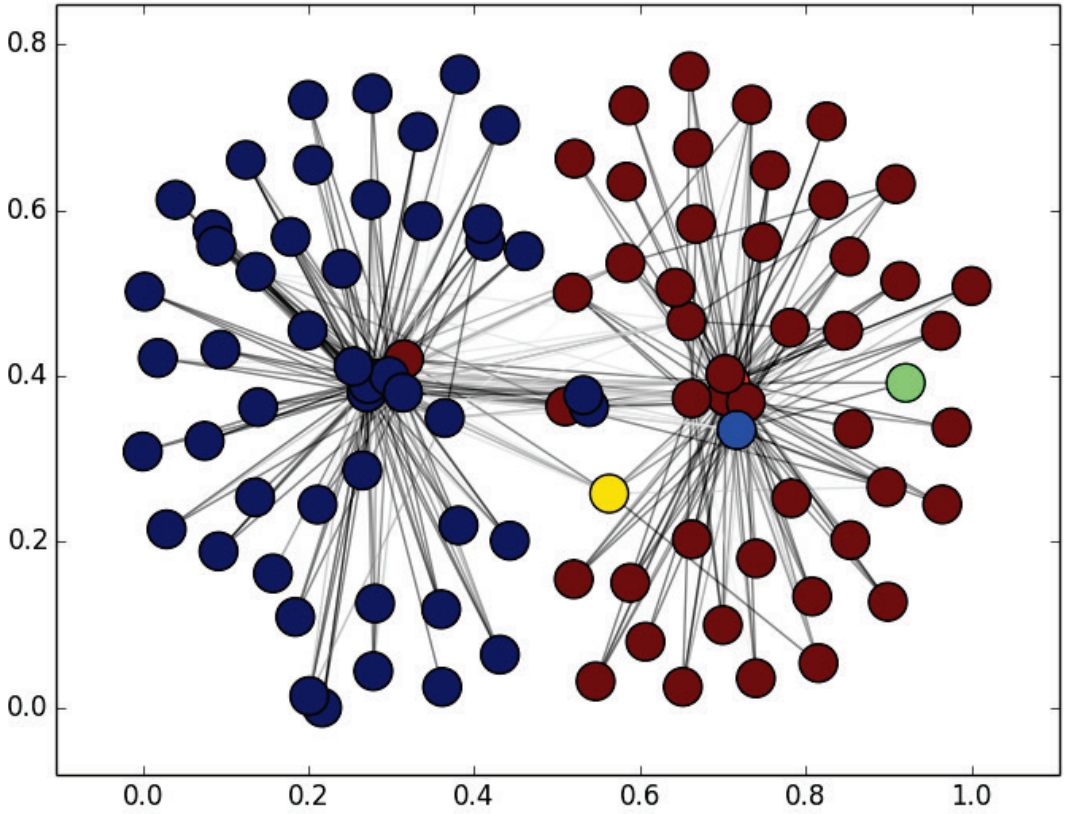
Collectives Time 1



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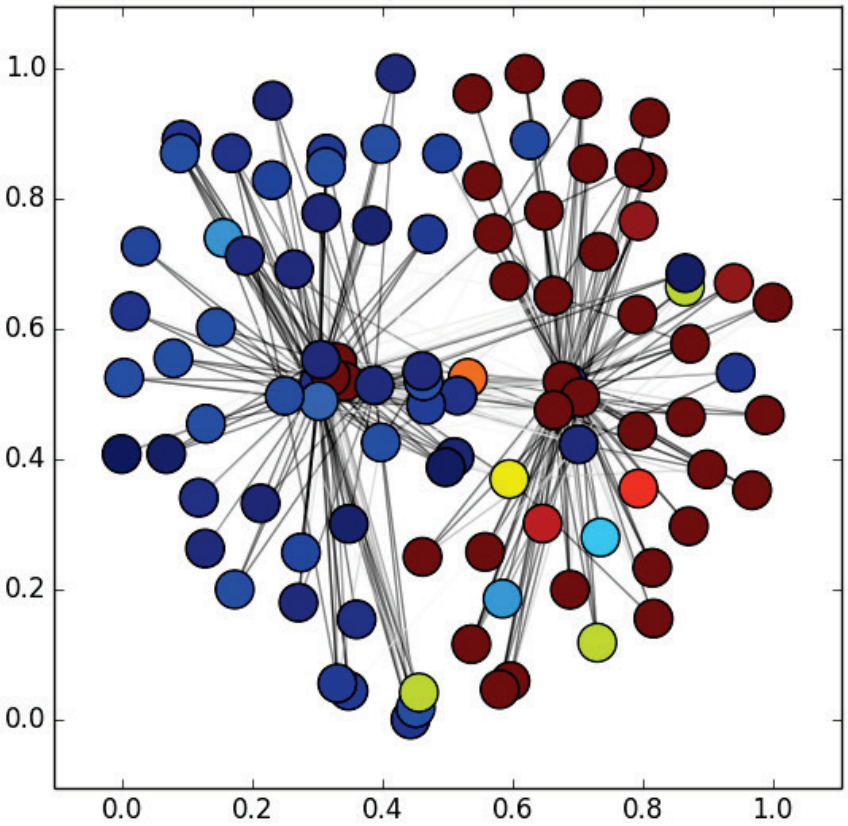
Collectives Time 2



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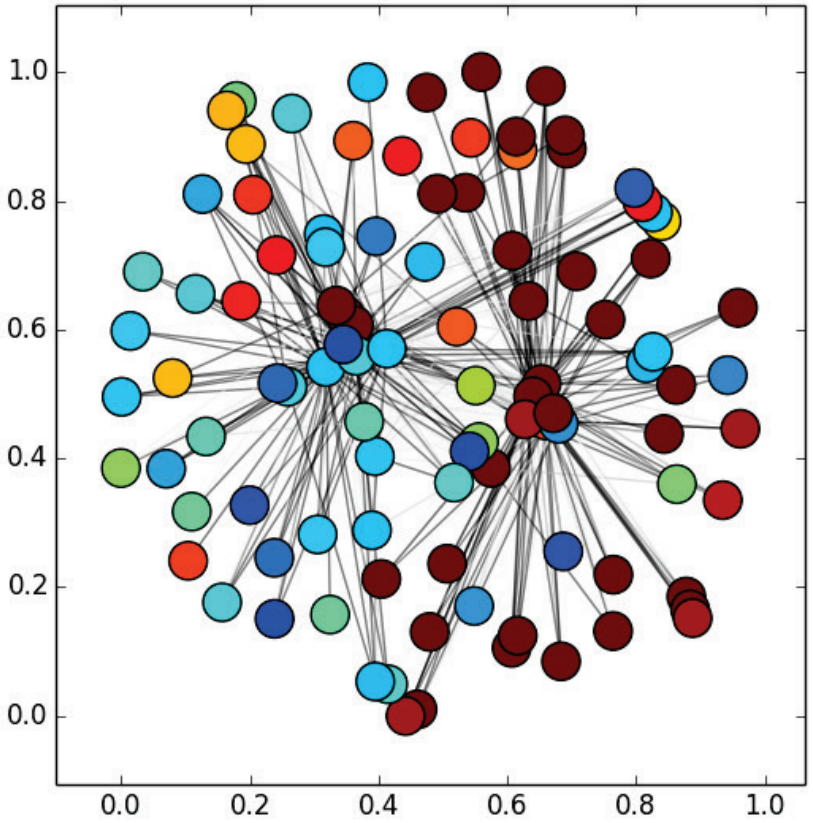
Collectives Time 3



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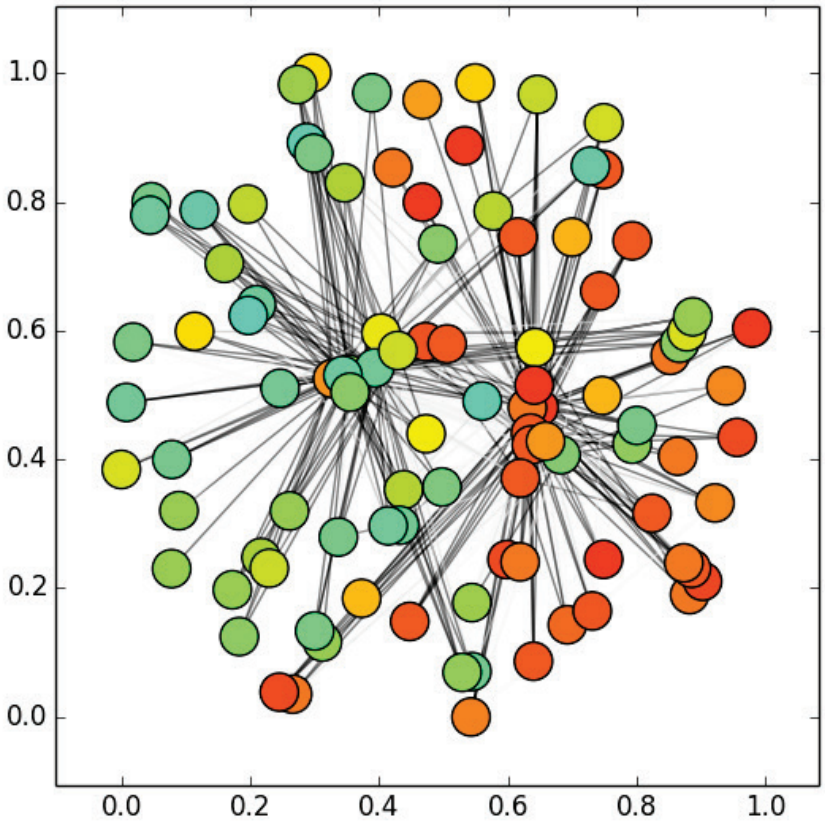
Collectives Time 4



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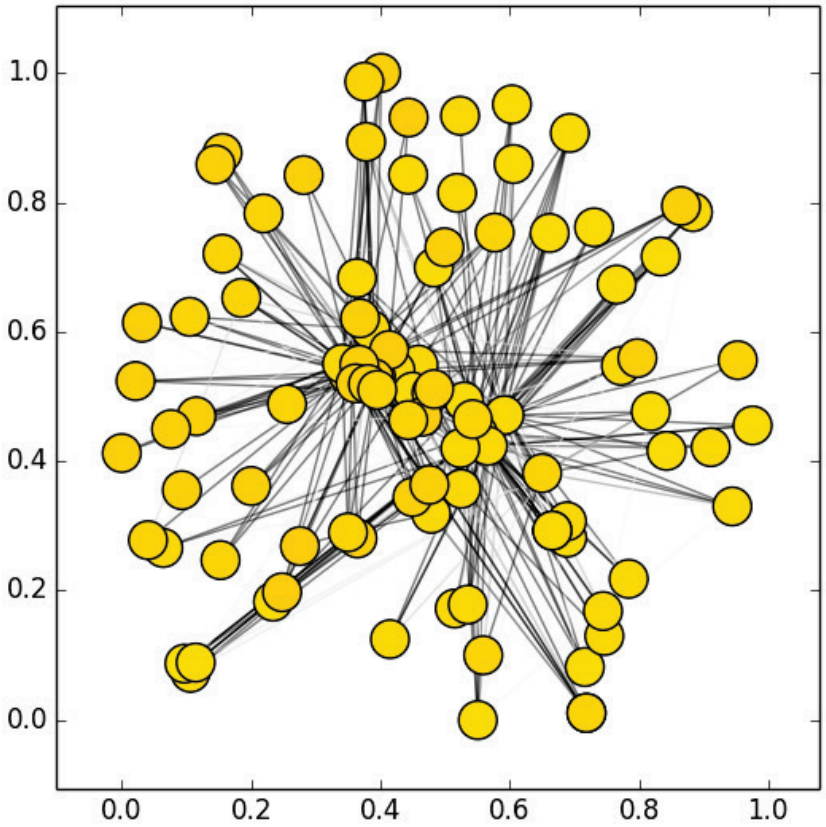
Collectives Time 5



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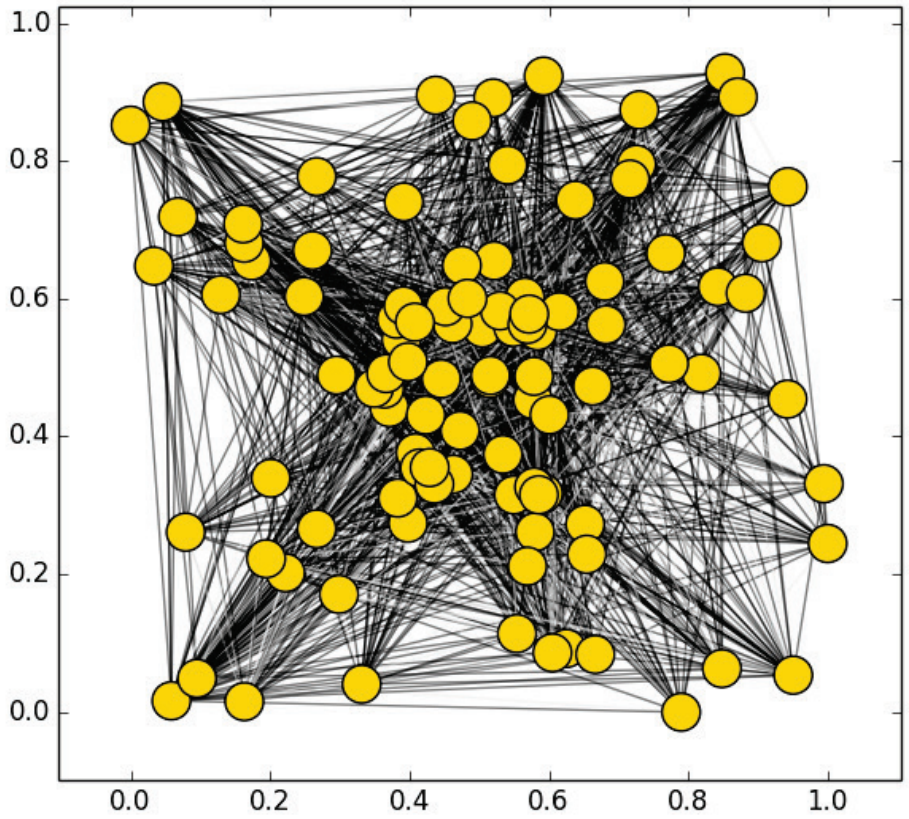
Collectives Time 6



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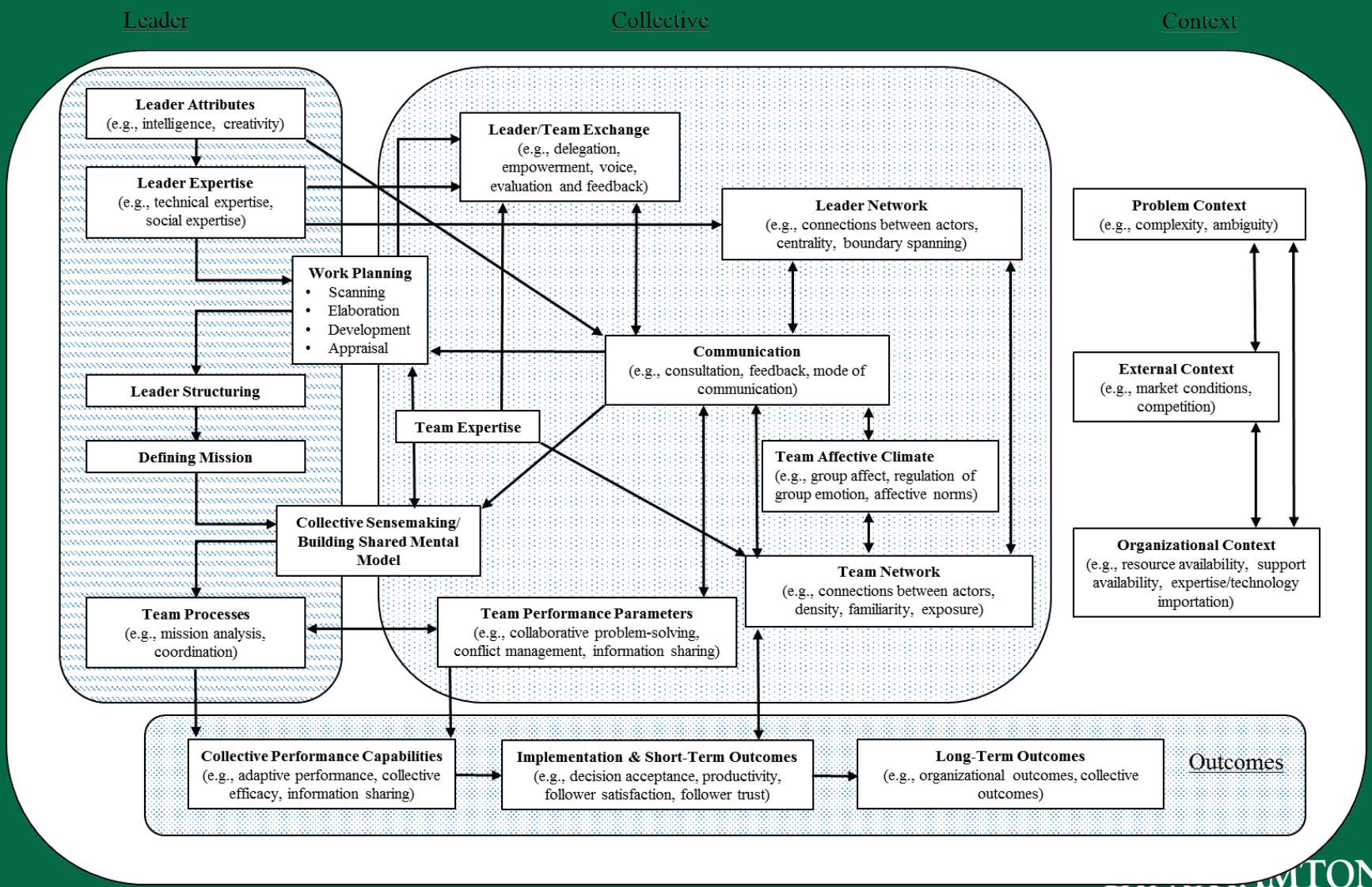
Collective Model



Collective: Interview Support

"As part of the selection process for astronauts, we run them through an experiential course/field exercise and look for competencies. During a ropes course challenge, they need to meet certain obstacles and are expected to change leadership positions after they meet each obstacle. We want to see if they are good leaders as well as good followers during this time. One of the things we are interested in is how can you be competitive but still be a good follower? And some can't give up being a leader. Broadly speaking, during this ropes course, we are looking at candidates' communication style, leadership, followership, and how good of a 'team player' they are."

Psychological Operations, Behavioral Health and Performance

"*One of the most important aspects of being an effective leader is knowing what questions to ask. It's easy to come up with a plan when you are the expert in that area but you may not have technical expertise in certain areas. That means you need to know strengths and weaknesses of yourself and others. You need to gain an understanding of how to ask what other options are out there while still keeping the goal in front of the team. "*

Psychological Operations, Behavioral Human Performance

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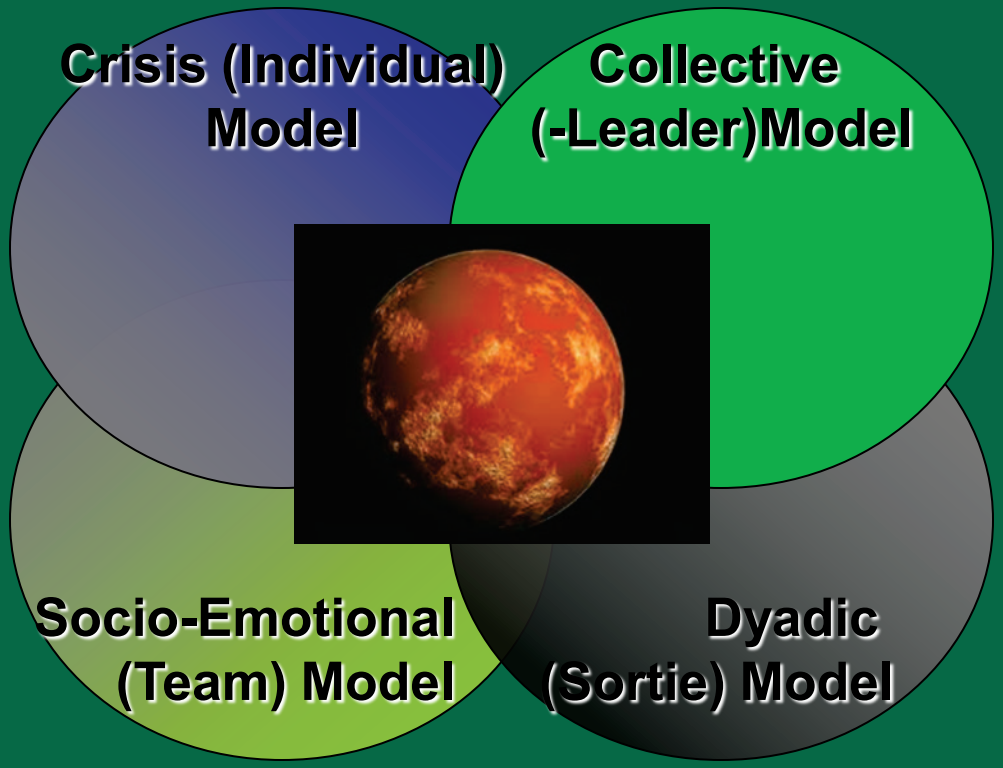
Leadership and Team Dynamics Integration



Multi-Level Social & Emotional Dynamics & Problem-Solving

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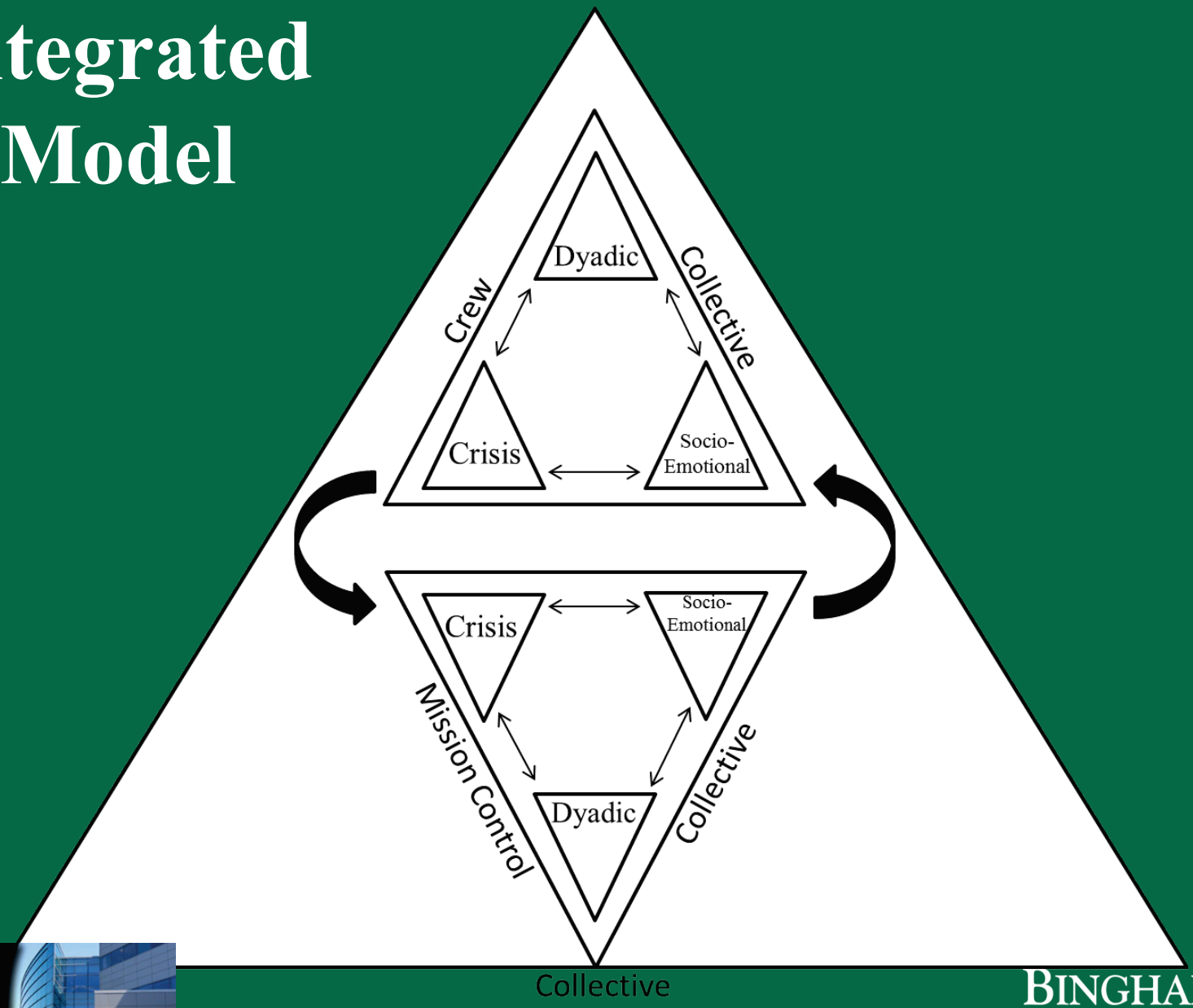
Integrated Model



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Role Switching between Mission Control and Crew

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Role Switching between Crew Members

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Role Switching between Crew Members

Role Switching between Crew Members

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Role Switching between Crew Members

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Role Switching between Crew Members

Sensemaking / sensegiving

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Variables & Levels for Leadership & Team Dynamics

STAGE AND CONSTRUCTS	LEVEL OF ANALYSIS
Pre-Flight to Early Flight	
Team/Crew Formation and Assembly	
Personality ("Big Five")	Individual
Creativity	Individual
Work Overload	Individual
Affect Management	Individual
Affect Control	Individual
Early Flight to Mid-Flight	
Leadership Dynamics	
Pragmatic-Crisis Leadership	Individual
Individualized-Dyadic Leadership	Dyad
Shared-Socio-Emotional Leadership	Team/Crew
Collectivistic-Collective Leadership	Collective
Integration Leadership Approaches	Multi-Level
Team/Crew Dynamics	
Shared Mental Models	Team/Crew
Leveling and Boredom	Individual
Cohesiveness and Role Shifting	Team/Crew
Climate	Team/Crew
Conflict	Team/Crew

Variables & Levels for Leadership & Team Dynamics

STAGE AND CONSTRUCTS	LEVEL OF ANALYSIS
Mid-Flight to Late Flight	
Team/Crew Performance and Maintenance	
Performance (Quality, Quantity, General, Specific)	Individual Team/Crew Organization (NASA) Multi-Level
Affect	Individual
Stress	Individual Team/Crew
Conflict	Team/Crew Team-Organization (Crew-NASA)
All Stages	
Contextual Factors	
Cultural Values (Power Distance, Individualism-Collectivism)	Society/Country
Organizational (Space Agency) Values	Organization
Turbulence	Organization/Collective
Crises	Organization/Collective
Cliques	Team/Crew
Gender	Individual/Collective

Note: Although relevant for more than one stage, variables are listed for the primary stage of flight

Validation & Test of Model

- Multiple Studies and Multiple Methods
- Eliminate Single-Study and Common-Method Bias Potential
- Cross-Validation of Results
- Designs: Historiometrics, Experiments, Simulations, Dynamic & Multi-Level Modeling
- Results: Basis for Crew Selection & Training

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Studies

Mission Reports & Other Docs—Historiometrics: Content-Coding of AAR's and Audio Tapes

Experimental/Laboratory—"True" Experiments using Student Subjects with Pre- and Post-Measures and Manipulations

Interviews—Former Astronauts & Mission Control Personnel (Semi-Structured with "Probing")

Surveys—Current and Former NASA Personnel

Houston Habitat—Observations & Experiments

Agent-Based Simulations & Dynamic Models of Interactions, Networks, & Collectives

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Potential Contributions

An approach that is interdisciplinary in nature, integrating management and industrial/organizational psychology literatures

A new, integrative model of leadership and team dynamics that will work well in long-term space flight—there and back safe with mission success

Examination of leadership and team dynamics as context-relevant notions going beyond analogue environments

A multi-source, multi-method, multi-study design that includes data (primary and secondary) from former astronauts and past missions

Inclusion of multiple levels of analysis as well as multi-level and cross-level ideas and tests

Creation and implementation of key "countermeasures" to enhance long-term space flight for crew selection, training, & performance

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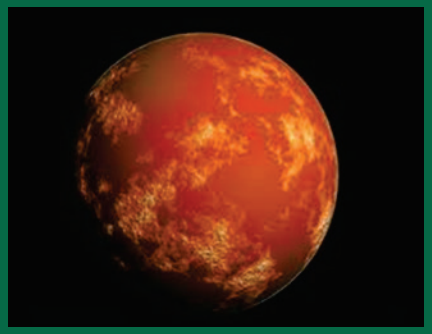
Leadership, Levels, & NASA: Mars Mission



Thank You

Questions & Comments?

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