

# Preparing for the unexpected

## ***Moon 2020 – 2030***

*A New Era of Coordinated Human and Robotic Exploration*

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## Focus in this presentation

1. Coping with unexpected scenarios - **Key issues**  
(illustrated by a spacewalk 16 July 2013)
  - Knowledge gaps and operator aspects related to human – robotic strategies and multilateral cooperation
2. To cope with human errors and create safety in lunar exploration – **training** as a measure
  - Innovative training modes assisting human actors dealing with unexpected conditions and events
3. Preparation for the unexpected – A holistic approach

# Coping with unexpected scenarios

## Spacewalk 16 July 2013 by Luca Parmitano

After 6 min of planned 6,5 hours

**Crew:** 1 Italian, 3 Russian, 2 American

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C: "Squeeze my hand if you are fine" P: Gives OK signal	P moves inside the air lock before C. Minutes of repressurizing the air lock.	Think of a plan (Open helmet, and probably lose consciousness)

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Instructions from fellow space station resident (Karen Nyberg)	Team ready to help. Unfasten helmet and lift it off	Relief when see the inner door open

# Key issues

Distance 1: Perception of roles, leadership, personality

Distance 2: Communication, different codes/signs/symbols, language

Distance 3: Different value; ideological and cultural

Distance 4: Perception of external world, and internal emotions

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# “Incommunicability”

- In synthesis, difficulties or inabilities in communication and information sharing. E.g the difficulty in decoding a sign you have never seen before or sharing an experience never encountered before
- Within a Team, Perfect Communicability and Total Incommunicability are just the extremes of a continuum

**The “Degree of Incommunicability”** is what matters, and what should be measured and accounted for, when facing the unexpected

When incommunicability prevails, the “unexpected” cannot be dealt, analyzed, or managed by a team. *Should we treat IPS as a matter of luck?*

*Cultural Misunderstandings increase incommunicability likelihood*



incommunicable 🔊

[in-kuh-myoo-ni-kuh-buh l]

Spell Syllables

Word Origin

adjective

1. incapable of being communicated, imparted, shared, etc.
2. not communicative; taciturn.

Origin of incommunicable



# Merriam-Webster dictionary definition

"Incommunicable." *Merriam-Webster.com*.

Merriam-Webster, n.d. Web. 9 Dec. 2015.

## Definition of INCOMMUNICABLE

: not communicable: as

**a** : UNCOMMUNICATIVE

**b** : incapable of being communicated or imparted

—**in·com·mu·ni·ca·bil·i·ty** \-,myü-ni-kə-'bi-lə-tē\ *noun*

—**in·com·mu·ni·ca·bly** \-'myü-ni-kə-blē\ *adverb*

## Examples of INCOMMUNICABLE

<the vastness of the universe is *incommunicable*>

## Origin of INCOMMUNICABLE

Middle French or Late Latin; Middle French, from Late Latin *incommunicabilis*, from Latin *in-* + Late Latin *communicabilis* communicable

First Known Use: 1568



## Related to INCOMMUNICABLE

### Synonyms

indescribable, indefinable, ineffable, inenarrable, inexpressible, nameless, uncommunicable, unspeakable, unutterable

### Antonyms

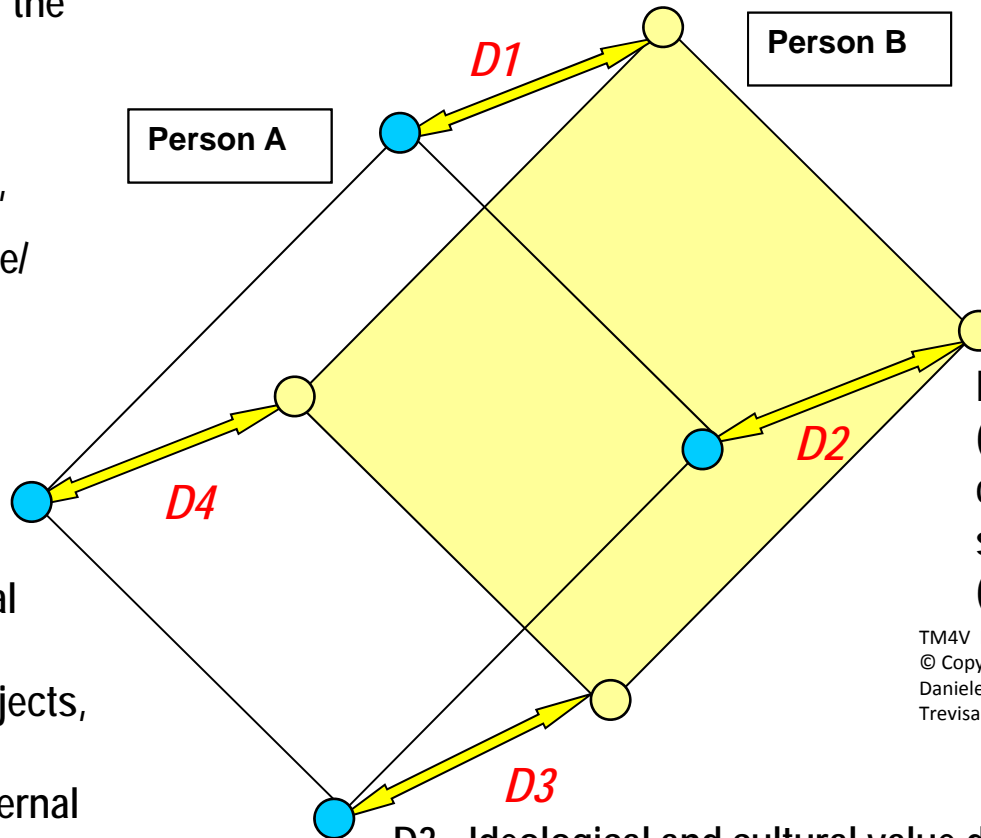
communicable, definable, expressible, speakable

# The 4 personal distances (4DM – 4 Distances Model) that can predict and measure incommunicability. Any of these distances can be high or low, single or combined

D1 - Distance of the Self:

- (a) biological differences,
- (b) identity/ role/ archetype/ personality differences

D4 - Referential distance (personal perceptions): (a) external world objects, experiences, knowledge (b) internal world (emotional past and present)

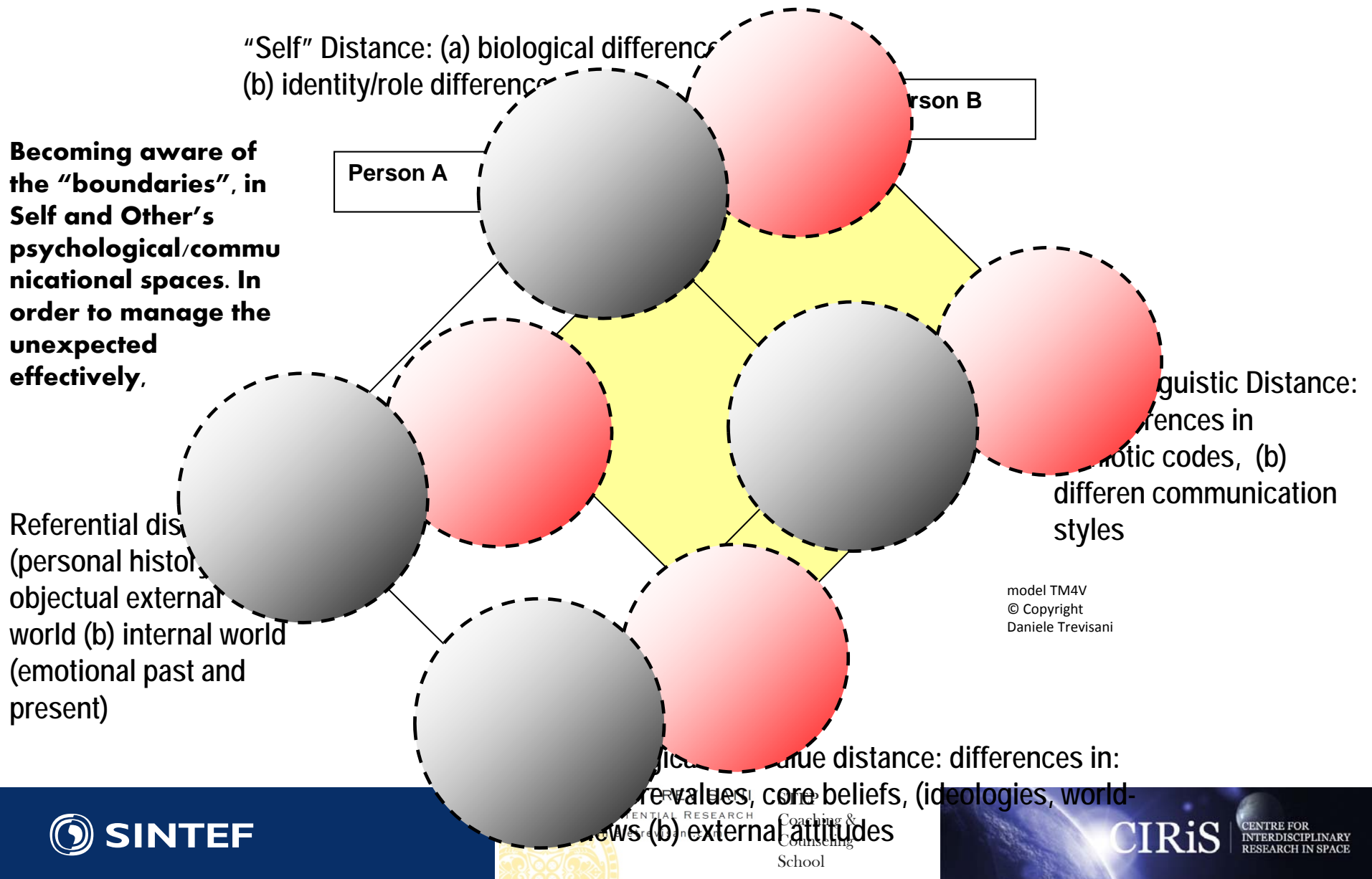


D2 - Code Distance (Semiolinguistic): (a) content - signs, symbols, language (b) *communication*

TM4V Model  
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Trevisani

D3 - Ideological and cultural value distance: differences in: (a) core values, core beliefs, (ideologies, world-views) (b) external attitudes

## Intercultural Crews: how much “Common Ground” is needed? How will we meet the challenge of training Crew Members and Mission Control on finding the right distances?



## A tentative Matrix for managing unexpected Crew Communication conditions (within an Intercultural system or crew)

<i>Effect</i> ⇨	<b>Irrelevant</b>	<b>Mild</b>	<b>Severe</b>	<b>Absolute</b>
<b>D1 Role Perceptions</b>	CONDITION DOES NOT EXIST	I do not like you I start to see a part of yourself that I did not know Eg. I think that Mission Control should be here with me to understand me	We argue on our self-perception and get angry at each other I think I am better than you	I want to rule over you, you want to rule over me. Severe conflict. Death of one part is seen as good for the other.
<b>D2 Communication Code Differences</b>	I read a poetry or a book in my own language in my personal time, even if you do not understand it	We think that the meaning of a concept (eg) "success" or "hospitality" are the same and universal but they are not	I do not understand you (partially) We do not know how to share a message or idea	I do not understand you completely Loss of coding and decoding ability. Noise without meaning
<b>D3 Value Differences</b>	We vote for different parties but are united in a common purpose	I start to think you do not like me	We have radically different assumptions	We believe in completely different values and priorities. We do not like other's values and we hate them
<b>D4 Perceptual and Objectual Differences</b>	My past is different from yours, even if we share something	Part of my training in my personal history has been different from yours but we have good common grounds	I believe that based on my experience, your solution is damn wrong	We think of each other that we do not have a clue of what we are individually experiencing or deciding about

# Example in human-robotic cooperation strategies

## **(D1) Role Perceptions**

- Who leads who? In which circumstances?
- When should humans lead, in which robots alone, in which Mission Control? How to switch from one to another in a safer mode

## **(D2) Communication Code Differences**

- What codes (commands) will be needed to overcome a robot decision?
- What codes (commands) will be needed by robots to overcome a human decision (e.g, in case of human error)?

## **(D3) Value Differences**

- What values will be used in taking hard decisions? (E.g. Life first or mission first?)

## **(D4) Perceptual and Objectual Differences**

- What realities can be forecasted and what cannot?

# Training to create safety in lunar exploration

To face "absurd" situations – The unexpected

Problem of incommunicability	Training
Distance 1: Perception of roles, leadership, personality	To switch leadership: When and how shall crew take action? (Not waiting for an order → becoming the decision maker) Drama techniques
Distance 2: Communication and different codes/signs/symbols, language	Interpretation of signs, symbols and communication Intercultural crew communication Team training (All actors: crew, control rooms, robots)
Distance 3: Different value; ideological and cultural	Change mode from normal → crises/ catastrophe Obeisance → Survival Lack of understanding → Shared situational awareness Complete mission/ science ↔ Safety and life
Distance 4: Perseption of external world, and internal emotions	To switch mode from information → emotion sharing Change from internal dialogue → communication Enhanced consciousness and mental training

# Deciding scenarios and key issues

## The Human Dependability Model (HuDeM) project

Trine Marie Stene (Project Manager)

Fabio Restagno (Technical Officer at ESA )

[Fabio.Restagno@esa.int](mailto:Fabio.Restagno@esa.int)

**Main objective:** To define a human dependability model and to develop an analytical methodology and procedural approach for space application

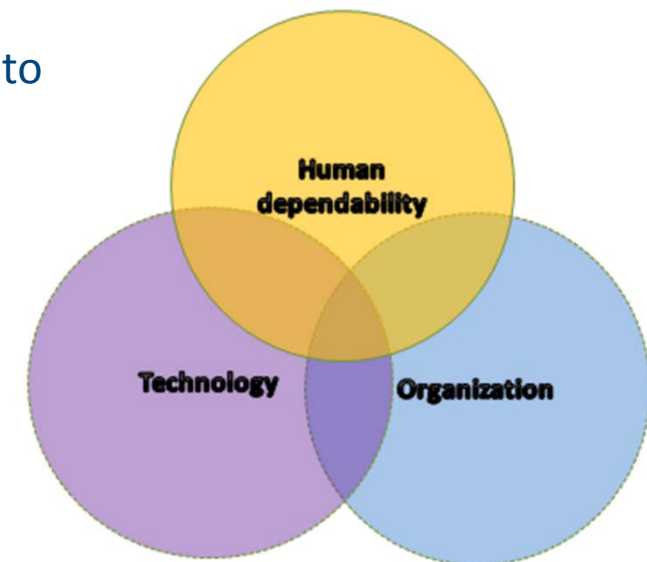
### Human factors/ dependability

Apply systematic methods and knowledge about people to evaluate and improve the interaction between

Individuals

Technology

Organisations



**Aim** is to create a working environment that contributes to achieving *healthy, effective* and *safe* operations

# HuDeM project for space application

**Spin-in:** Experiences from other industries: aviation, oil & gas, nuclear industry, railway  
Case study from ISS

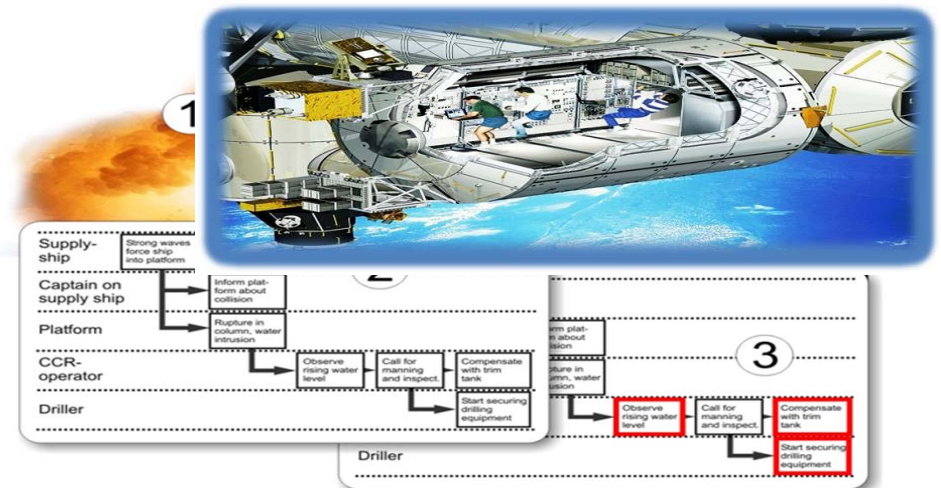
Important to involve key stakeholders

## Checklist

- To decide critical key elements
- Performance shaping factors

## Scenario analysis

- Actors
- Steps
- Critical situations



1. Choose scenario

2. Description through STEP

3. Critical tasks, and analysis through observation, ..action..

# Preparation for the unexpected – a holistic approach

- Limitations of previous training

## **Research & Development (R&D)- Develop and document relevant training cases**

- *Key issues and scenarios* - Human Dependability Model (ESA/ESTEC project 2013)
- *Innovative training modes* assisting human actors dealing with unexpected conditions and events (active training and increased situational awareness)

## **Man Technology Organisation (MTO) approach based on perspectives from :**

- Safety Science
- Human Factor Science
- Communication and Semiotics
- Intercultural Communication
- Knowledge Management
- Leadership
- Education and training

## Focus in this presentation

### 1. **Key issues** - Coping with unexpected scenarios

(illustrated by a spacewalk 16 July 2013)

- Knowledge gaps and operator aspects related to human – robotic strategies and multilateral cooperation

### 2. **Training** - To cope with human errors and create safety in lunar exploration

- Innovative training modes assisting human actors dealing with unexpected conditions and events

### 3. A **holistic approach** necessary to prepare for the unexpected

Human in future space missions encompasses

**the risk of human error**

but also ...

**the human capacity to perform well and avoid  
catastrophes!**

*Thank you for Your attention!*



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Brit-Eli Danielsen



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# Actors in lunar exploration

1. Human – human operators unexpected conditions in astronaut crew
2. Human – robot unexpected situations
3. Control room with astronaut crews unexpected situations
4. Programmers defining operational modes of robots when unexpected events or conditions occur (including focus on "machine – human enhanced empathy)

# In small-case or worse-case scenarios, good management depend on reducing relational distance

- From the Moon 2030 Vision *“From nationally and private sector driven missions to a truly multilateral effort, including both institutional and private sector partners”*. → This requires **Intercultural Problem Solving (IPS) Skills** – far beyond any average level

What does effectively increase within this framework of multilateral cooperation?

1. Increase in national diversity and national cultural diversity
2. Increase in professional diversity
3. Increase in complexity of Mission Command & Control
4. Increase in complexity due to robotic agents and the cultural backgrounds of programmers
5. Overall increase in possibility of cultural distances interferences especially under pressure,
6. Possibility of unwanted miscommunications among team members, misunderstandings
7. Need to improvise (cultural diversity as a resource and not only an obstacle), need to share, need for situational problem solving, and sometimes, need for speed in decision making
8. The higher the relational distance, the higher the probability of slower team decision making when facing the unexpected
9. Need for a Model for identifying “Incommunicabilities”