



MIRKO TRISOLINI



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EDUCATION

University of Southampton

Southampton, UK

Ph.D., Department of Astronautics

(Oct. 2014 – Feb. 2020)

Dissertation: *Space System Design for Demise and Survival*

Advisors: Prof. Hugh Lewis and Prof. Camilla Colombo

- Applied design-for-demise principles to system design and optimisation of spacecraft configurations
- Developed an object-oriented re-entry software to satellite disposal and their casualty risk
- Developed a debris impact assessment tool to assess the damage caused by space debris impacts
- Performed multi-objective optimisation using evolutionary algorithms to optimise the system design of spacecraft configurations
- Performed sensitivity analyses using the Sobol technique.

University of Pisa

Pisa, Italy

M.S., Aerospace Engineering

(Oct. 2010 - Oct. 2013)

Thesis: *Hall Thruster Direct-Drive Assessment and Demonstration*

Advisors: Prof. Mariano Andreucci, Eng. Tommaso Misuri

Honors: *Magna cum laude*

University of Pisa

Pisa, Italy

B.S., Aerospace Engineering

(Sep. 2007 - Nov. 2010)

Thesis: Fluid dynamics characteristics of diffusers and methods to improve their efficiency

Advisor: Prof. Maria Vittoria Salvetti

Honors: *Magna cum laude*

Additional courses

- Fundamentals of Life Cycle Assessment (Corso Base di LCA), Politecnico di Milano, 2020
- Perturbation methods for astrodynamical applications, Prof. Martin Lara, Politecnico di Milano, 2018
- ESA Concurrent Design Workshop, ESA Redu Centre, Redu, Belgium, 2017
- Threaded Programming with OpenMP, University of Southampton, Southampton, 2016
- Message Passing Programming with MPI, University of Southampton, Southampton, 2016

RESEARCH EXPERIENCE

Politecnico di Milano

Milano, Italy

Marie Skłodowska-Curie Individual Fellowship - Global Fellow

Mar. 2021 – Present

Department of Aerospace Science and Technology

- Performed target selection for particle collection missions identifying suitable target asteroids
- Developed ejecta model defining particle ejecta characteristics after kinetic impacts
- Devised collection strategies based on the ejecta dynamical behaviour

Politecnico di Milano

Milano, Italy

PostDoc Fellow

(Feb. 2018 – Mar. 2021)

Department of Aerospace Science and Technology

- Studied the re-entry and fragmentation of spacecraft and asteroids developing novel techniques for fragmentation modelling and uncertainty propagation
- Performed propagation and reconstruction of uncertainties using a continuum approach integrated by Gaussian Mixture Models fitting and n-dimensional simplex-based interpolation
- Developed interface between long-term propagation and destructive re-entry analysis

Sitael s.p.a. Space Propulsion, Systems, and Services

Pisa, Italy

Internship – Direct-drive Hall thruster system study and demonstration

(Dec. 2012 – Oct. 2013)

- Executed the first experiment in Europe of a Direct-Drive Hall effect thruster system
- Performed the design, manufacturing, and testing of the EMI filter, and contributed to the assembly of the test bed inside the vacuum chamber
- Performed data acquisition and post-processing
- Performed a system and trade-off study for mission applications of a direct-drive Hall thruster

TEACHING EXPERIENCE

Politecnico di Milano

Milano, Italy

Teaching Assistant, Orbital Mechanics

AY 2018-19 | AY 2019-20

Department of Aerospace Science and Technology

- Contributed to drafting the syllabus of the course of orbital mechanics
- Prepared and administered exercise tutorials and lectures (22 hours) to 200 students
- Drafted exams, administered grades, and assisted in exams invigilation
- Supported students through meetings and Q&A sessions

Politecnico di Milano

Milano, Italy

Teaching Assistant, Introduction to Space Mission Analysis and Design

AY 2018-19

Department of Aerospace Science and Technology

- Contributed to drafting the syllabus of the course of introduction to mission analysis and design
- Prepared and administered exercise tutorials (20 hours) to 100 students
- Drafted exams, administered grades, and assisted in exams invigilation
- Supported students through meetings and Q&A sessions

University of Southampton

Southampton, UK

Teaching Assistant, Spacecraft Orbital Mechanics and Control

AY 2015-16 | AY 2016-17

Department of Astronautics

- Prepared and administered exercise tutorials to 50 students
- Assisted in exams invigilation

University of Southampton

Southampton, UK

Teaching Assistant, Advanced Computational Methods I

AY 2015-16

- Assisted students during Python programming laboratories

University of Southampton

Southampton, UK

Teaching Assistant, Thermofluid Dynamics

AY 2015-16

- Assisted in the setup of laboratory experiments of thermofluid dynamics
- Showed experimental procedure to students and assisted them during experimental activities

TRACK RECORD

Journal publications

Trisolini M., Colombo C., "Re-entry prediction and demisability analysis for the atmospheric disposal of geosynchronous satellites," *Advances in Space Research*, 2021, In press.

Limonta S., Trisolini M., Colombo C., "Fragmentation model and strewn field estimation for meteoroids entry," *Icarus*, 2021, Vol. 367, 114553, DOI: <https://doi.org/10.1016/j.icarus.2021.114553>

Trisolini M., Lewis H. G., Colombo C., "Constrained optimisation of preliminary spacecraft configurations under the design-for-demise paradigm," *Journal of Space Safety Engineering*, 2021, Vol. 8, Issue 1, pp. 63-74, DOI: <https://doi.org/10.1016/j.jsse.2021.01.005>

Trisolini M., Colombo C., "Propagation and reconstruction of re-entry uncertainties using continuity equation and simplicial interpolation," *Journal of Guidance, Control, and Dynamics*, 2021, Vol 44, Issue 4, pp. 793-811, DOI: <https://doi.org/10.2514/1.G005228>

Trisolini M., Lewis H.G., Colombo C., "Predicting the vulnerability of spacecraft components: modelling debris impact effects through vulnerable-zones," *Advances in Space Research*, 2020, Vol. 65, Issue 11, pp. 2692-2710, DOI: <https://doi.org/10.1016/j.asr.2020.03.010>

Maury T., Colombo C., Trisolini M., Loubet P., Gallice A., Sonnemann G., "Assessing the impact of space debris on orbital resource in Life Cycle Assessment: a proposed method and case study," *Science of Total Environment*, 2018, Vol. 667, pp. 780-791, DOI: <https://doi.org/10.1016/j.scitotenv.2019.02.438>

Trisolini M., Lewis H.G., Colombo C., "Spacecraft design optimisation for demise and survivability," *Aerospace Science and Technology*, 2018, Vol. 77, pp. 638-657, DOI: <https://doi.org/10.1016/j.ast.2018.04.006>

Trisolini M., Lewis H.G., Colombo C., "Demisability and survivability sensitivity to design-for-demise techniques," *Acta Astronautica*, April 2018, <https://doi.org/10.1016/j.actaastro.2018.01.050>

Trisolini M., Lewis H.G., Colombo C., "Demise and survivability criteria for spacecraft design optimisation," *Journal of Space Safety Engineering*, 2016, DOI: [https://doi.org/10.1016/S2468-8967\(16\)30023-4](https://doi.org/10.1016/S2468-8967(16)30023-4)

Pampaloni A., Trisolini M., Andrenucci M., Misuri T., "A Direct-Drive System Demonstration for a Low-Power Hall Thruster," *Journal of Propulsion and Power (JPP)*, 2014, DOI: <https://doi.org/10.2514/1.b35253>

Conference proceedings

Trisolini M., Colombo C., Tsuda Y., "Ejecta analysis for an asteroid impact event in the perturbed circular restricted three body problem," *31st JAXA Workshop and Flight Mechanics and Astrodynamics*, Virtual, 26-27 July 2021.

Romano M., Muciaccia A., Trisolini M., Di Lizia P., Colombo C., Di Cecco A., Salotti L., "Characterising in-orbit fragmentations with the PUZZLE software," *8th International Conference on Astrodynamics Tools and Techniques*, Virtual, 23-25 June 2021.

Scala F., Trisolini M., Colombo C., "Attitude control of the disposal phase of the eCube mission for atmospheric data acquisition," *16th International Conference on Space Operations*, Virtual, 3-5 May 2021.

Muciaccia A., Romano M., Trisolini M., Colombo C., "In orbit fragmentations localisation: study and characterisation of the events," *16th International Conference on Space Operations*, Virtual, 3-5 May 2021.

Colombo C., Trisolini M., Scala F., Brenna M. P., Gonzalo J. L., Antonetti S., Di Tolle F., Redaelli R., Lisi F., Marrocchi L., Alberti M., Francesconi A., Olivieri L., Tipaldi M., "e.Cube mission: the Environmental CubeSat," *Proceedings of the 8th European Conference on Space Debris*, ESOC, Darmstadt, 20-23 April 2021

Colombo C., Trisolini M., Gonzalo J. L., Giudici L., Frey S., Kerr E., Sánchez-Ortiz N., Letizia F., Lemmens S., "Design of a software to assess the impact of a space mission on the space environment," *Proceedings of the 8th European Conference on Space Debris*, ESA ESOC, Darmstadt, 20-23 April 2021

Borelli G., Trisolini M., Massari M., Colombo C., "A Comprehensive Ranking Framework for Active Debris Removal Mission Candidates," *Proceedings of the 8th European Conference on Space Debris*, ESA ESOC, Darmstadt, 20-23 April 2021

Romano M., Muciaccia A., Trisolini M., Colombo C., Di Lizia P., Di Cecco A., Salotti L., "PUZZLE software for the characterisation of in-orbit fragmentations," *Proceedings of the 8th European Conference on Space Debris*, ESA ESOC, Darmstadt, 20-23 April 2021

Trisolini M., Colombo C., "Integrating density-based uncertainty propagation with object-oriented re-entry models," *Proceedings of the 8th European Conference on Space Debris*, ESA ESOC, Darmstadt, 20-23 April 2021

Limonta S., Trisolini M., Frey S., Colombo C., "Modelling the break-up and re-entry propagation of meteorites through a continuum approach," *Proceedings of the 71st International Astronautical Congress (IAC) – The Cyber Space Edition*, paper IAC-20-C1.6.10, 12-14 October 2020

Trisolini M., Colombo C., "Modeling re-entry break-up uncertainties with continuity equation and Gaussian mixture models interpolation," *Proceedings of the 2020 AAS/AIAA Astrodynamics Specialist Conference – Virtual Lake Tahoe*, 9-12 August, Lake Tahoe, USA, 2020, AAS 20-636

Trisolini M., Colombo C., "A density-based approach to the propagation of re-entry uncertainties," *Advances in Astronautical Sciences*, vol. 168, AAS 19-409, pp. 2241-2253.

Trisolini M., Colombo C., "Density-based approach for the propagation of re-entry uncertainties," *27th International Symposium on Space Flight Dynamics*, 24-28 February, Melbourne, Australia, 2019

Colombo C., Rossi A., Dalla Vedova F., Francesconi A., Bombardelli C., Trisolini M., Gonzalo J.L., Di Lizia P., Giacomuzzo C., Bayajid Khan S., and Garcia-Pelayo R., "Effects of Passive De-Orbiting Through Drag and Solar Sails and Electrodynamic Tethers on the Space Debris Environment," In *Proceedings of the 69th International Astronautical Congress*, Bremen, Germany, 1-5 October 2018

Trisolini M., Lewis H.G., Colombo C., "Demisability and survivability multi-objective optimisation for preliminary spacecraft design," *Proceedings of the 2017 International Astronautical Congress (IAC)*, 25-29 September 2017, Adelaide, Australia

Colombo C., Letizia F., Trisolini M., Lewis H. G., Chanoine A., Duvernois P.-A., Austin J. and Lemmens S., "Life cycle assessment indicator for space debris," *7th European Conference on Space Debris*, Darmstadt, Germany, 18-21 April 2017.

Trisolini M., Lewis H.G., Colombo C., "On the demisability and survivability of modern spacecraft," *Proceedings of the 7th European Conference on Space Debris*, 18-21 April 2017, ESOC, Darmstadt, Germany

Trisolini M., Lewis H.G., Colombo C., "Multi-objective optimisation for spacecraft design for demise and survivability," *Proceedings of the Stardust Final Conference*, 31st October – 4th November 2016, ESA ESTEC, The Netherlands

Trisolini M., Lewis H.G., Colombo C., "Spacecraft design optimisation for demise and survivability," *Proceedings of the 2016 International Astronautical Congress (IAC)*, 26-30 September 2016, Guadalajara, Mexico

Trisolini M., Lewis H.G., Colombo C., "Demise and survivability criteria for spacecraft design optimisation," *Proceedings of the 8th IAASS Conference*, 18-20 May 2016, Melbourne, Florida, USA

Trisolini M., Lewis H.G., Colombo C., "Survivability and Demise Criteria for Sustainable Spacecraft Design," *Proceedings of the 2015 International Astronautical Conference (IAC)*, 12-16 October 2015, Jerusalem, Israel

Pampaloni A., Trisolini M., Andrenucci M., Misuri T., "A Direct-Drive System Application for Hall Effect Thrusters," *Proceedings of the 2013 International Electric Propulsion Conference (IEPC)*, 6-10 October 2013, Washington DC, USA

Book chapters

Colombo C., Letizia F., Trisolini M., and Lewis H. "Space Debris: Risk and Mitigation," In *Frontiers of Space Risk*, pp. 105-141, CRC Press, 2018

Reports

D'amore G., Perozzi E., Colombo C., Trisolini M., Frey S., Gonzalo Gómez J. L., Di Lizia P., Rossi A., Alessi E. M., Schettino G., Francesconi A., "SST Fragmentation Services, within the activities that the Italian Space Agency (ASI) carries out within the EUSST consortium," Final Report – ASI contract study, Jan 2019

Colombo C., Gonzalo J. L., Trisolini M., Di Lizia P., Della Vedova F., Rossi A., Alessi E. M., Francesconi A., Giacomuzzo C., Khan S. B., Bombardelli C., Pelayo R. G., "Environmental aspects of passive de-orbiting devices," Final Report, Dec 2018

Workshops

Trisolini M., Gkolias I., Colombo C., "Demisability analysis of re-entering structures on resonant trajectories," *5th International Space Debris Re-entry Workshop*, Darmstadt, Germany, 2nd December 2020

Maury T., Colombo C., Trisolini M., Loubet P., Gallice A., Sonnemann G., "Assessing the impact of Space Debris on the orbital resource in LCA," *Clean Space Industrial Days*, ESTEC, The Netherlands, 2018

Maury T., Colombo C., Trisolini M., Loubet P., Gallice A., Sonnemann G., "Integrating space debris modelling to environmental impact studies thanks to the Life Cycle Assessment (LCA) framework," *5th European Workshop on Space Debris Modelling and Remediation*, CNES HQ, Paris, France, 2018

Maury T., Colombo C., Trisolini M., Loubet P., Gallice A., Sonnemann G., "Considering Space Debris related impacts into the LCIA Framework," *SETAC Europe Annual Meeting*, Rome, 2018

Proposals

e.Cube – The environmental CubeSat [Passed technical evaluation phase]

2020

Call for tender “Future missioni per Cubesat” of the Italian Space Agency (ASI)

Consortium: Politecnico di Milano, D-Orbit, Temis srl, Intelligentia srl

Design, development, and deployment of software infrastructure to assess the impact of a space mission on the space environment [Awarded] 2020

Call for tenders of the European Space Agency (ESA)

Consortium: Politecnico di Milano, Deimos Space UK

e.Inspector [Not awarded] 2020

Call for tender of the European Space Agency (ESA)

Consortium: Politecnico di Milano, D-Orbit

CRADLE: Collecting asteroid orbiting samples [Awarded] 2019

EU Marie Skłodowska-Curie Individual Fellowship – Global Fellowship

Consortium: Politecnico di Milano, Japan Aerospace Exploration Agency, University of Padova, D-Orbit

Life Cycle Assessment Indicator [Awarded] 2016

Call for tender of the European Space Agency (ESA)

Consortium: University of Southampton, Politecnico di Milano, Deloitte Sustainability

MAJOR INTERNATIONAL COLLABORATIONS

ESA - Design, development, and deployment of software infrastructure to assess the impact of a space mission on the space environment contract N. 4000133981/21/D/KS

Politecnico di Milano, Deimos Space UK

Feb. 2021 – Present

Development of a framework, including a web user interface, to assess the impact of missions on the space environment, in support of achieving space sustainability.

- Task manager for Task 1.3 and 1.5
- Coordinated the development of the space debris index and of the space environment capacity
- Performed sensitivity analysis on explosion and collision probability

H2020 “SST Space Surveillance and Tracking” contract N. 785257 (2-3SST2016)

Politecnico di Milano, Italian Space Agency (ASI)

(Oct. 2020 –May 2021)

Development of a software suite for the development and expansion of the Italian Space Surveillance and Tracking network.

- Supported the development of the software tool for the characterisation and localisation of in-orbit fragmentations.

ASI - SST Fragmentation Services

Politecnico di Milano, Italian Space Agency (ASI)

(Nov. 2018 – Jan. 2019)

Analysis of the state-of-the-art techniques to model fragmentation, propagate the fragments and predict the effects on the space environment, under the Italian SST framework

- Performed literature review and comparison of software tools dedicated to the analysis of fragmentation events during re-entry and for the prediction of their effects on ground.

ESA – “Environmental Aspects of Passive Deorbiting Devices” contract N. 4000119560/17/F/MOS

Politecnico di Milano, IFAC-CNR, LuxSpace

CISAS University of Padova, Universidad Politécnica de Madrid (Feb. 2018 – Nov. 2018)
 Analysis of the environmental impact and risks of passive deorbiting devices, including drag and solar sails, and electrodynamic tethers.

- Performed collision probability analyses of spacecraft equipped with drag and solar sails
- Performed sensitivity analyses of collision and penetration probabilities

ESA – “Life Cycle Assessment Indicator for Space Debris” contract N. E1SATEC-SC-SOW-2015-003

Politecnico di Milano, Deloitte Sustainability, University of Southampton (Sep. 2016 – Feb. 2018)
 Development of an indicator for the environmental impact of a space mission under the LCA paradigm.

- Performed casualty risk and demisability analysis using ESA software DRAMA
- Performed sensitivity analysis on re-entry conditions and S/C characteristics
- Contributed to the definition and development of the life cycle assessment indicator
- Contributed to the definition of test cases for the life cycle assessment indicator

GRANTS & FELLOWSHIPS

MSCA Individual Fellowship – Global Fellowship (€ 229,704.64)	2020
ESA Sponsorship for the ESA Concurrent Design Workshop	2017
ESA Sponsorship for (67 th International Astronautical Congress, Guadalajara, Mexico)	2016
Royal Aeronautical Society Travel Grant (8 th IAASS Conference, Melbourne, Florida)	2015

SUPERVISION AND MENTORING

Ph.D Students Supervision

Politecnico di Milano

Pan Sun 2021
Topic: Study of the long-term dynamical behaviour of MEO satellites under the influence of uncertainties. Exploiting the phase-space description of the dynamics and Gaussian Mixture Models to effectively propagate uncertainties.

Lorenzo Giudici 2021
Topic: Development of a continuum technique for the accurate propagation of space debris generated by in-orbit fragmentations, and computation of the collision probability on space objects.

M.S. Student Supervision

Politecnico di Milano

Valeria Trozzi 2020
Thesis: Investigation of potential definitions of the space environment capacity to pursue sustainability of outer space activities over the long term

Christian Fusaro 2020
Thesis: Interface between the long-term propagation and the destructive re-entry phases exploiting the overshoot boundary: the case of INTEGRAL

Marco Paolo Brenna 2020
Thesis: CubeSat mission design for in-orbit environment characterisation

Simone Limonta 2019
Thesis: Meteoroids and asteroids: a density-based approach for entry, fragmentation and descent through the atmosphere

B.S. Student Supervision

Politecnico di Milano

Esther Galliot

2018

Topic: Classification of space missions based on the service provided towards reaching the UN sustainable development goals

INVITED LECTURES

Re-entry from the Moon and beyond, PoliMoon, Milan Planetarium, Milan, Italy	29/10/2019
COMPASS Group Presentation, Modena Planetarium, Modena, Italy	27/04/2019

LEADERSHIP & OUTREACH

DAER Plastic Free	Milano, Italy
<i>Politecnico di Milano, Department of Aerospace Science and Technology</i>	Apr. 2019 – Present
Inter-departmental initiative to raise awareness and reduce plastic waste at the Department of Aerospace Science and Technology of the Politecnico di Milano.	

DAER Open Labs	Milano, Italy
<i>Politecnico di Milano, Campus Bovisa</i>	Nov. 2018
Outreach activity organised by the Department of Aerospace Science and Technology to disseminate the activities of the department mainly devoted to children and their families.	
<ul style="list-style-type: none">Developed interactive tools for public engagement	

MeetMeTonight	Milano, Italy
<i>Giardini Indro Montanelli and Virtual</i>	Sep. 2018 Sep. 2019 Nov. 2020
European Researchers Night organised by the Municipality of Milan.	
<ul style="list-style-type: none">Developed interactive tools for public engagement	

NASA International Space Apps Challenge Milano	Milano, Italy
<i>Politecnico di Milano, Campus Bovisa</i>	Oct. 2018 2019
NASA International Space Apps Challenge is an international hackathon that takes place during 48 consecutive hours in cities all around the globe at the same time.	
<ul style="list-style-type: none">Responsible for team coordination and task assignmentCoordinated venue set-up and catering for the event	

PROFESSIONAL AFFILIATIONS

Italian Association of Aeronautics and Astronautics (AIDAA)	2021 – Present
American Institute of Aeronautics and Astronautics (AIAA)	2018 – 2020
Institution of Engineering and Technology	2015 – 2016
Royal Aeronautical Society	2015 – 2016