

Mars climate orbiter failure

[Science](#), [Astrology](#)



This paper addresses the possible causations and engineering failures that led to the demise of NASA's Mars climate orbiter mission in 1998 by summarising and analysing the technical and human factors leading to the incident. The primary fault at hand was the failure to programme and operate the trajectory of the spacecraft in the required manner, causing the space probe to enter a trajectory that took the spacecraft within the minimum altitude at which the spacecraft could survive and operate effectively.

Furthermore, any underlying issues that could have led to failures in the Mars climate orbiter's mission will be brought to attention as well as if any regulatory actions were ignored or not followed correctly, which if were followed correctly, may have prevented the engineering failures associated with this disaster. This report also identifies the post disaster action taken to prevent similar engineering and communication failures in future projects.

Introduction

The Mars climate orbiter (MCO) was launched on December 11, 1998 and was lost on September 23, 1999. The MCO had unintentionally been projected into a path that took it to an altitude too close to Mars' surface. Ultimately, the MCO had not been engineered with a structure or with the expensive materials required for it to survive within the planet under investigation's atmosphere, despite the probe costing \$327.6 million to research and produce. This meant that the spacecraft either disintegrated in Mars' atmosphere or deflected and re-entered heliocentric space.

The primary cause for the disappearance of the MCO spacecraft was the failure of NASA's ground teams to use metric units when coding its trajectory

paths. English imperial units were implemented into the coding programme used for the MCO's computers as these were developed by Lockheed Martin Astronautics, who designed and built the spacecraft, provided data in imperial units. Ultimately, this meant the trajectory data was entirely incorrect and post-failure calculations showed that the spacecraft was on a path that would have taken the MCO to within 57 kilometres of the surface of Mars. Previous calculations showed that the MCO was only capable of surviving in altitudes higher than 80 kilometres.

These failures were fatal and should have been a key consideration for NASA before launching the MCO as one of the key objectives of the MCO mission was to Map the thermal structure of the atmosphere from the surface to 80 km altitude, therefore altitude trajectory should have been a key issue when testing its programming, as the MCO needed to be placed at very specific altitudes in order to successfully complete this objective.

Aims of this report

1. To analyse the technical faults that led to this disaster.
2. To analyse the human faults and errors that led to this disaster.
3. To investigate any underlying causes leading to this disaster such as ethical concerns and misconducts.
4. To discuss which factors were most at fault for this disaster.
5. To determine the most significant failure in leading to this disaster.
6. To discuss which new laws, regulations and practices were introduced as a result of this disaster and how significant this event was in terms of future engineering projects.

Analysis of disaster

The first and arguably most significant technical fault that led to this disaster was the fact that the MCO's programming system incorporated the wrong numerical units for NASA's use of the product. Also, the fact that there were no conversion algorithms incorporated in the MCO's computers or displays of which numerical unit system was in use meant that the MCO was bound to be projected into an undesired trajectory with NASA's American teams controlling the space probe in metric units. The effect of these faults coupled together ultimately caused the space probe to enter an altitude at which it could not operate and would be destroyed or lost in space.

Secondly, another key technical fault was in play leading to this disaster as errors went undetected within NASA's computer models of how thruster firings on the spacecraft were predicted and then carried out on the spacecraft during its mission. These computational models were also programmed in metric units so when it was discovered that the MCO was headed on the wrong trajectory during the mission, the calculations produced in an attempt to salvage the mission were incorrect.

The teams working on the trajectory path of the MCO requested calculations of how long to fire the MCO's small thrusters to deflect the path of the MCO away from Mars' atmosphere. The results of these calculations were given in pound-force seconds rather than Newton seconds, which the software of the probe's computers incorporated. Ultimately, this meant that when the small thrusters were used, there was not enough force programmed into its software to manoeuvre the MCO away from the atmosphere of Mars,

meaning it remained on its incorrect trajectory that led to it being lost in Mars' atmosphere.