



U T S D C

REQUEST FOR PROPOSAL

UNIVERSITY OF TORONTO SPACE DESIGN CONTEST

October 18, 2009



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Section 1

Introduction

The University of Toronto Space Design Contest (UTSDC) is an annual contest which presents a space related problem to teams of up to 5 students and tasks them to design and propose an innovative solution. Designs are judged by distinguished professors at the University of Toronto and members of the space industry. Teams prepare a solution for that year's problem, submit a short report, and have the opportunity to present it in the Design Fair hosted in May. Each year's design challenge is delivered through a Request for Proposal (RFP). This year's RFP is presented in this document.

1.1 Near Earth Objects

Over the last 30 years, Near Earth Objects (NEOs) have garnered special interest as the awareness of the potential dangers posed by them to Earth, has increased. A NEO is defined as a Solar System object (typically asteroids and comets) in an orbit which allows them to enter Earth's neighbourhood with a perihelion distance of less than 1 Astronomical Unit (AU). More specifically, a Potentially Hazardous Object (PHO) is an object greater than 140 meters and passes within 0.05 AU of Earth's orbit¹. Scientists agree that throughout Earth's history, collisions with NEOs have significantly shaped the geological and biological structure of the planet. Consequently NASA, ESA and other scientific bodies are scanning the night sky, in an effort called Spaceguard, to find potentially dangerous NEOs and are researching in collision mitigation techniques to defend our planet.

¹NASA, Near-Earth Object Survey and Deflection Analysis of Alternatives; Report to Congress, 2007



Section 2

Problem Summary

Imagine that it is Year 2065 and the world's Spaceguard efforts has found a potentially hazardous asteroid, Kheper, 260m in size, with a 1 in 3000 chance of colliding with the Earth in 2088. The world governments are looking for a feasible collision mitigation strategy. International coordination has voted that the strategy must use non-explosive (nuclear, traditional explosive, etc.) means to carry out the mission. The most promising proposal will have the backing and funding of the world governments. In addition to designing a mitigation strategy, a contingency plan must also be developed in case the strategy is unsuccessful. The winner will be chosen from a pool of candidate teams who decide to respond to this Request for Proposal. Candidates should assume the existence of previous UTSDC structures, including:

- The Tesus orbital space colony
- The Space Hotel designed by Celestial Eagle Technologies
- The Perseus Space Emergency Response System
- The NOMAD Lunar Base
- The Student Training Facility designed by APEX
- Any space infrastructure that currently exists
- Any feasible technology or infrastructure that could exist in 2065

Scientists are still observing Kheper and are planning to collect data on its mass, material makeup and possible impact location. These will be provided to the candidates, along with a set of parameters identifying its orbit, after registration (see Section 3.2).

2.1 Objectives

The objectives of the collision mitigation strategy are as follows:

1. Design a mitigation method to deflect Kheper before 2085.
2. Demonstrate your mitigation method is technically sound.
3. Demonstrate your mitigation method has a higher chance of success than other possible methods.
4. Ensure your mitigation method is safe to all life on Earth.
5. To prepare for a worst case scenario, develop a contingency plan to reduce the effects of impact, should the mitigation method be unsuccessful.

2.2 Proposal Formatting

The Proposal (Final Report) should be printed on A4 paper with 1 inch margins, using a 12-point standard font type. Reports shall be no longer than 20 pages (excluding title page, table of contents, diagrams, bibliography and appendices). **The content within the 20 pages must be self sufficient and any information past this will not be read.** Appendices, however may be included at the end of the Report. There is no limit to the length of the Appendices, but they must only be used for background calculations or for clarification purposes. **They must not introduce new design features.** The main body of text should refer to the Appendices when necessary. Proposals should include a table of contents, title page, and works cited (see Section 4.4). The outline of the Proposal should follow that of Section 2.3. However, headings/sections may be rearranged or changed completely if the authors submit a document clearly outlining where the required information for each heading in Section 2.3 is located in their Report. Submission instructions and evaluation criteria are listed in Sections 3.4 and 4.1.

2.3 Proposal Content

Every Proposal submitted must contain the following content. It is recommended that teams outline their Proposal using the headings of the following subsections.

2.3.1 Mitigation Strategy

Function

The mitigation strategy which each team designs will differ from team to team. What makes your team's strategy unique? *How* will it carry out its mission in deflecting Kheper? What technologies will it use? Will it be manned or autonomous? If you are making contact with the asteroid, how will you reach it?

Timeline

Given that Kheper is predicted to impact Earth in 2088, what is the timeline for your mitigation strategy. Provide a detailed chronological timeline of when you will begin design/construction, when you launch your mission, what times you will perform critical functions related to your strategy and when your mission is expected to successfully deflect Kheper.

Technical Risks

With any deflection strategy there will always be some tradeoffs. What are the major technical risks and bottlenecks of your design? How do these affect the likelihood of success? What improvements could be made to increase chances of success? What makes your design more promising than others?

Infrastructure

A mission of this scale will require a great deal of organizational effort. What kind of manpower will you need to be successful in your mission? What kind of secondary technology (ground stations, observatories, etc.) will you be needing to ensure your mission runs smoothly?

2.3.2 Contingency Plan

Strategy

Considering the size of Kheper and the predicted drop-point, what dangers will an impact introduce to Earth's population? How will you prepare for these dangers? If there is a need to evacuate some of the population, will you use any of the existing UTSDC structures in your

contingency plan (see Section 2)? Is there any chance of food shortage, water contamination or any other natural disaster after-effects? If so, how will you address these?

Infrastructure

A Contingency Plan of this scale will require a great deal of organizational effort and time. What kind of manpower will you need to ensure your plan succeeds? What kind of infrastructure will you need to protect the population? What will you need to build/design to avoid any natural disasters caused by the impact?

2.3.3 Finance

Mission Budget

The mission you choose to carry out will be a collaborative effort between governments, private agencies and your team. Reasonable financial support will be given to your team by world governments. However it must be shown, that this aid is used sensibly and responsibly. Given the financial history of spaceflight missions, estimate the costs associated with your mitigation strategy. Furthermore, estimate the costs associated with your proposed Contingency Plan. Present your estimates in a budget breakdown to show where each cost is allocated and how you arrive at your final cost estimate.

Budget Justification

Demonstrate the reasoning behind the values provided in your Mission Budget. How do they compare to similar missions done in the past by government and space agencies? Why do they differ or why are they so similar to these benchmarks?



Section 3

Project Timeline

The UTSDC project has several deadlines which are important to note. Registration forms and further information can be found on UTSDC's website (www.utspace.com). Please read the following Section carefully.

3.1 Welcome Night and Information Session

The Information Session is to give prospective and registered contestants an in depth overview of the University of Toronto Space Design Contest. The event will be hosted at the University of Toronto St. George Campus on **December 3, 2009**. The session will run in the evening and will cover this year's topic, overview of the judging scheme and will allow participants to ask questions about this year's RFP. Guests at the event will include the Contest Executives and selected researchers at the University from Astrophysics and Aerospace.

Contestants are required to express their intent on attending the event by e-mailing ask@utspace.com before **November 26, 2009**. After this date, new attendants to the event will not be accommodated.

3.2 Registration

Contestants are required to complete a team registration form located on UTSDC's website under the "Registration" section. Upon registration, a set of parameters identifying Kheper's orbit, its mass, material makeup and possible impact location will be distributed. A registration fee of \$80 must be sent in to accompany registration before Friday **December 11, 2009**. Registration after this date will require a late fee and contestants must submit a payment of \$90 before Friday **January 8, 2009**. After this date, registration will be closed.

Contestants are encouraged to ask their school, family and friends for sponsorship. Payment must be made in cash, cheque, or money order. It can be mailed in, dropped off, or brought in to the contestant information session.

Payments should be made out to:

University of Toronto Space Design Contest
c/o U of T Engineering Society
Sanford Fleming Building, Suite B740
10 King's College Rd.
Toronto, Ontario CANADA M5S 3G4

3.3 Space Workshop

The Contest Workshop will be held on Saturday **February 20, 2010** at the University of Toronto Institute for Aerospace Studies. The event will allow contestants to personally meet leaders in Aerospace research. Teams will be paired with a single researcher and will receive advice on the current state of their project. Since each researcher will have a particular concentration, afterwards, teams will be allowed to share their progress with the other researchers at the Workshop.

The event will run from 10:00AM to 4:00PM. Food will be provided. Contestants are required to express their intent on attending the event by registering on our website (www.utspace.com) under the "Registration" section, before **February 6, 2010**. After this date, new attendants to the event will not be accommodated.

The Workshop will be held at:

University of Toronto Institute for Aerospace Studies
4925 Dufferin Street
Toronto, Ontario
CANADA M3H 5T6

3.4 Final Report

The Final Report is one of the three deliverables for the Contest and is worth 60% of the contestants' overall score. Final reports must be submitted in both a hardcopy and softcopy (electronic) format. The softcopy version of the report must be in **PDF** format. The hardcopy version **must** be accompanied by a health and a release form for *each* contestant. These can be found on UTSDC's website under the "Downloads" section. The hardcopy version of the Final Report and health/release form can be submitted by mail or in person (during 9 AM to 4 PM on weekdays) to:

University of Toronto Space Design Contest
c/o U of T Engineering Society
Sanford Fleming Building, Suite B740
10 King's College Rd.
Toronto, Ontario
CANADA M5S 3G4

The softcopy version of the Final Report should be mailed to *judging@utspace.com*. The Final Reports must be postmarked/received (hardcopy) or timestamped (softcopy) no later than Monday **March 29, 2010**. For a more information on the Final Report please see Section 4.1.

3.5 Design Fair

The Design Fair is aimed to let contestants showcase their work to the UTSDC Judges and the general public. This year, the Fair will be held during **May 13 to May 16, 2010** on the University of Toronto St. George Campus. Contestants will be housed in one of the residence facilities during the duration of the Fair. Each team must exhibit a Design Display and give a Design Presentation on their proposal. These two deliverables encompass 40% (20% each) of the contestants' overall score.

For a more information on the Design Fair Presentation and Display, please see Sections 4.2 and 4.3.



Section 4

Evaluation

Each team must submit and exhibit 3 deliverables: Final Report (60%), Design Presentation (20%) and Design Display (20%). The following section explains the strict guidelines, which must be adhered to, for each deliverable. Please read carefully.

4.1 Final Report

The Final Report is worth 60% of the contestants' overall score. Reports shall be no longer than 20 pages (excluding title page, table of contents, diagrams, bibliography and appendices). **The content within the 20 pages must be self sufficient and any information past this will not be read.** Appendices, however may be included at the end of the Report. There is no limit to the length of the Appendices, but they must only be used for background calculations or for clarification purposes. **They must not introduce new design features.** For more information on the Report format see Section 2.2.

A hardcopy and softcopy (electronic) format must be submitted and postmarked no later than Monday **March 29, 2010**. The hardcopy version **must** be accompanied by a health and a release form for *each* contestant. Instructions for the delivery of the hardcopy of the Final Report are found in Section 3.4. The electronic copy of the Final Report must be in **PDF** format. All other formats (.doc, .docx, .tex, etc.) will not be accepted.

The mark breakdown of the Final Report is as follows:

Mitigation Strategy	45%
Function	15%
Timeline	10%
Technical Risks	10%
Infrastructure	10%
Contingency Plan	30%
Strategy	18%
Infrastructure	12%
Finance	15%
Mission Budget	5%
Contingency Plan Budget	5%
Budget Justification	5%
Formatting	10%
Structure	5%
Clarity	5%
TOTAL	100%

For more information on the requirements of each category, please see Section 2.3. A detailed marking rubric will be released after the final Registration date.

4.2 Design Fair Presentation

At the Design Fair, each team is expected to give a 10 minute presentation, highlighting the team's proposal to address the given problem (Section 2) to a panel of judges. There will be an additional 5 minutes at the end of the presentation for questions from the judges. The presentation should include the major design features of the mitigation method and the proposal for the contingency plan. Before presenting, each team **must** provide the judges with a copy of written presentation materials and references.

A panel of judges will mark the teams, based on on several criteria including content,creativity, structure, group dynamics, time management, delivery, use of visuals/ aids, and ability to answer questions. A detailed marking rubric will be released after the final Registration date.

4.3 Design Fair Display

Each team must bring a Display to the Design Fair to exhibit their work to the judges and general public. During this part of the Fair, teams are expected to stay alongside their Displays. The Display should be visually appealing and should contain critical information related the team’s design. Teams are encouraged to use models, diagrams and graphs to convey their information. Contestants may bring a laptop with media or material for the Display.

Displays will be scored based on several criteria including creativity, visual appeal, quality of information, discussion with judges, and presentation delivery. A detailed marking rubric will be released after the final Registration date.

4.4 Academic Honesty

The University of Toronto Space Design Contest takes academic honesty very seriously and any team that is caught plagiarizing material will be **disqualified** from the Contest. Plagiarism is the “*use or close imitation of the language and thoughts of another author and the representation of them as one’s own original work*”¹. This includes, but is not limited to, any language in the Final Report, text, diagrams or ideas not of the authors. A simple rule is the following: if it is not your own idea, cite it. Simply using a bibliography is not acceptable.

Works cited must follow a **MLA Citation Style**. An example of this style presented below:

Our spacecraft will use a bi-propellant engine, which has been shown to have more versatile options² than regular monopropellant, electric and solid propellant engines.

4.5 Penalties

Penalties will be assigned to reports which do not follow the outlined formatting in Section 2. Further penalties will be issued if there are missing citations or if the hardcopy submitted is not bound. A maximum penalty of 2.5% will be assigned *per* violation. The actual penalty value will be based on the severity of rule violation.

¹Random House, Random House Compact Unabridged Dictionary, 1995

²Humble, W., ”Space Propulsion Analysis and Design”, McGraw-Hill, 1995