# Lesson 4: Argument Design and Structure

Example of short research proposals (for in-class analysis of argument structure).

## Example of short research proposal 1:

Climate change remains an environmental problem of concern worldwide. Countries make use of a multi-pronged approach to tackle this problem. Among various sources of greenhouse gases, urban traffic is a major contributor to CO2 due to a large traffic volume in cities and the use of fossil fuels in automobiles. In the context of climate change mitigation, active modes of transport (walking and cycling) are encouraged and motorized modes of transport (private car, taxis, bus and train) are discouraged. However, the potential health benefits associated with active modes of transport remain uncertain. This project will involve the use of novel sensors to quantify the long-term health benefits associated with active modes of transport. Documentation of co-benefits (health and environmental benefits) associated with active modes of transport will encourage commuters to contribute to urban sustainable development.

## Example of short research proposal 2:

Air pollution is a leading risk factor for mortality and morbidity worldwide. The World Health Organization estimated that 7 million deaths are attributable to exposure to outdoor and indoor air pollution. Historically, spatial coverage of air quality monitoring stations has been limited by the high cost of instrumentation; urban areas typically rely on a few reference-grade monitors to assess population scale exposure. However, air pollutant concentrations often exhibit significant spatial variability depending on local sources and features of the built environment, which may not be well captured by the existing monitoring networks. This project will explore the development and applications of low-cost sensor-based air quality monitoring technology together with the use of a machine-learning tool as a complementary approach to provide insights into the spatial variation of air pollutants. Developing highly resolved air pollutant visual maps using GIS (global information system) will assist researchers, policymakers, and communities in developing new policies or mitigation strategies to enhance human health.

## Example of long research proposal 1:

Human driven climate change represents a major threat to the social and political stabilities of modern societies. However, the path toward decarbonisation is unsettled, especially for the transportation sector which mostly relies on fossil fuels. Many technical solutions are shifting the emissions to other locations or environmental issues (e.g., use of electricity by electric vehicles). Life cycle assessment (LCA) is a comprehensive approach that assesses the environmental burdens distribution of a product or a service across its life cycle stages, from “cradle to grave”. LCA is standardized for product-based assessments but is of limited use when applied to large-scale deployment of technologies or policy changes. Researches are needed to build bridges between LCA and other approaches to encompass behavioral changes, technological and economic developments and to better inform climate-change driven decisions.

## Objectives

The overarching objectives of the proposed research are to quantify the life cycle GHG emissions associated with light-duty vehicle fleets, and to assess changes in emissions as a function of large-scale deployment of technologies or policies.

## Work to date

I finished two studies in the first two years of my PhD, one of them has been accepted as paper in Environmental Science and Technology. In the first study, I focused on the system-scale assessment of lightweight material penetration (e.g., aluminum) in the U.S. light-duty fleet. As those materials are more energy intensive to produce but offer energy reductions during the vehicle use phase, I developed a bottom-up prospective fleet model combined with material flow analyses to build the fleet-scale assessment. In my findings, I outlined the economic and technological conditions that could maximise or minimize the GHG emission reductions and offered recommendations on the pace and timing of lightweighting to automobile manufacturers. In the second study, I focused on the fleet-scale assessment of deployment of fuel blends with higher ethanol levels in Canada and on relevant associated policies.

## Proposed work plan

In the remaining part of my PhD, I intend to focus on behavioral changes associated with electric vehicle deployment. Electric vehicle adoption changes the way we use vehicles, such as increases in vehicle ownership or changes in driving patterns, and these changes need to be assessed at local and global levels to ensure sustainable consumption. I plan to expand my bottom-up prospective fleet model with a Vehicle Consumer Choice model to interconnect electric vehicle deployment with driver choices. This expanded model will address the challenges of assessing large-scale deployment of electric vehicles, and of assessing vehicle policies to promote electric vehicle deployment. I will indeed evaluate the GHG emission mitigation potential of new designs in automotive policies, such as shifting away from tailpipe to LCA-based regulations.

Achieving a sustainable society requires knowledge on the implications of large-scale deployment of technologies or policies. The main contribution of the proposed work is to provide a comprehensive system-scale assessment of electric vehicle deployment in the U.S. and Canada and a systemic method to design sustainable automotive policies. The work is supervised by Professor Heather MacLean and is using the numerous models and databases previously developed by the group. I intend to concentrate my career, research, and skills on helping Canada transitioning toward a fairer and greener society, and I would greatly benefit from the support of the Graduate Scholarships in Sustainable Energy.

# Example of long research proposal 2:

In 2016, cities with more than 100,000 inhabitants concentrated 59.6% of the Canadian population. With the densification of urban cores, which regroup major activities, this percentage is expected to increase. The strategy of compact urban development is generally promoted for sustainable purposes. Unfortunately, it also results in the clustering of the population and of air pollutant emission sources, especially traffic.

The transportation sector is a large contributor to criteria air contaminant emissions and greenhouse gas (GHG) emissions. For instance, on-road vehicles contribute 34% of total nitrogen oxide (NOx) emissions. These emissions have significant health and environmental impacts on the society, including poor air

quality, and risks of mortality and morbidity in the exposed population. Many local governments have established targets of GHG emissions for future years and developed strategies to meet them. However, little attention is brought to the potential impact these strategies could have on air pollutant levels.

In the context of increasing concern for air pollution and human health, it is crucial to understand the key elements affecting the population exposure and to identify factors impacting human health. The first part of this thesis consisted in a large data collection campaign and in the development of maps of air pollutant concentrations for the City of Toronto. These maps are crucial for epidemiological studies investigating the health effects of air pollution exposure.

The second part of this thesis consists in analysing the impact of various transportation scenarios on the Greater Toronto and Hamilton Area (GTHA) air quality. Changes in fuel type (e.g., biofuel, electricity) and vehicle weight are often considered as solutions to reduce vehicle emissions, but the results of such strategies can be mitigated. For instance, since electric vehicles (EV) do not generate operating emissions, vehicle electrification has been promoted to reduce traffic-related air pollution. However, investigating the potential health benefits of the electrification of a vehicle fleet necessitates the inclusion of upstream emissions, i.e. emissions imputable to the generation of the electricity fueling EVs. Depending on the fuel mix used and the distance of power plants to dense areas of population, the generation of the extra electricity required by EVs could have health impacts offsetting the local benefits of EVs.

Several studies have investigated the impacts of different transportation scenarios on air quality and health using various emission inventories and air quality models. However, the lack of a refined transportation emission inventory enabling a rigorous evaluation of the impact of traffic on air quality is usually a limitation. More importantly, the choice of the air quality model biases the results as regional spatial resolutions usually employed are inadequate for accurately analysing exposures.

In the context of the GTHA, we propose to explore the impact of realistic transportation scenarios on population exposure to air pollution. A refined transportation emission inventory developed based on detailed traffic patterns for the GTHA will be coupled with an accurate air quality model to simulate levels of air pollution under business-as-usual conditions and under different scenarios. Changes of exposure to air pollution will be investigated from an equity point of view, and health impacts of exposure to air pollution will be estimated in order to provide recommendations in terms of public health.