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DATA511 - UW MSDS  
C4: Concept Production  
Geopolitics and Military Transfers  
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[GitHub Repository](#)  
[Dashboard on Tableau Public](#)

## Executive Summary

Military transfers represent one of the highest forms of diplomacy. They serve as a proxy to evaluate the depth of relationships between nations and provide insights into a nation or region's security status over time. Increased military trade often indicates that a country perceives its security situation as inadequate and is amplifying its stockpile to align with its strategic ambitions. Conversely, lower military trade relative to the size of a nation's economy suggests a sense of security and stability in the national psyche, often tied to a reduced threat perception.

Military transfers also respond to internal and external factors such as uprisings, skirmishes, and rebellions. Additionally, significant technological advancements in weaponry can prompt nations to rearm in order to stay competitive in a rapidly evolving global arms landscape. The data can further reveal a country's adherence to international treaties and regulations, as well as the scale, diversity, and specialization of its domestic arms manufacturing industry.

For these reasons and more, tracking military transfers offers valuable insights. Recognizing this, we decided to create a project centered on military transfers to develop a comprehensive tool for researchers, journalists, and other interested parties. We aimed to provide an integrated view that connects a country's domestic security dynamics with its international military activities.

Currently, there are no visualizations that fully encapsulate this space, bringing together elements like arms transfers, military expenditure, personnel deployment, and their evolution over time, on a single platform. This gap motivated us to design a tool that collates and visualizes these aspects, enabling exploration, analysis, and a better understanding of global military dynamics. It is a product of both intellectual curiosity and a desire to create a resource that synthesizes complex data into a unified, accessible format.

## **Concept Background**

### **Data Sources and Collection of the Data**

This project leverages three key datasets to provide comprehensive insights into military transfers and defense dynamics.

#### **1. Arms Transfer Database (SIPRI):**

The primary dataset is sourced from the Stockholm International Peace Research Institute (SIPRI) (accessible at <https://armstransfers.sipri.org>). This database has been tracking major conventional weapons—including aircraft, ships, missiles, and vehicles—since 1950. A unique feature of this dataset is the *Trend Indicator Value (TIV)*, a metric that assigns a standardized measure to transferred military equipment based on military capability, rather than financial value. TIV, thus, allows us to compare across weapons, across time, and across nations, in a coherent manner.

#### **2. World Development Indicators (World Bank):**

The second dataset is the World Development Indicators, maintained by the World Bank. This dataset provides detailed information on national trends, such as military personnel as a percentage of the labor force and military expenditure as a percentage of GDP over time. These indicators were critical for developing country profiles, offering insights into a nation's defense posture beyond its international arms transfers.

#### **3. Global Conflict Dataset:**

The third dataset, covering global conflicts, was uniquely created for this project due to the lack of a comprehensive existing resource. This dataset spans the period from 1998 to 2024 and documents major wars, uprisings, civil rebellions, coup attempts, and ethnic tensions across the world. It was compiled by aggregating information from multiple online sources, ensuring a broad and inclusive representation of conflicts.

## **Preparation of the Data**

### **Weapon Categorization**

The SIPRI dataset contained highly detailed weapon descriptions, often more granular than necessary for our purposes. To streamline the analysis, we introduced two new levels of grouping: Category and Sub-category.

- Category: A high-level grouping that includes broad classifications such as Aircraft, Helicopters, Unmanned Vehicles, Naval Vessels, Ground Vehicles/Artillery, Missiles/Rockets/Bombs, etc.
- Sub-category: A more detailed grouping within each category, including classifications like Surface-to-Air Missiles, Infantry Fighting Vehicles, Combat Vessels, Anti-Submarine Warfare Weapons, etc.

The full mapping of these categories can be found in the [description\\_mapping.csv](#) file within the project repository.

## Refining the SIPRI Transaction Data

The original SIPRI dataset represented each transaction as a single row, with separate columns for the recipient and supplier. To make the data more suitable for dashboard visualizations, we transformed it into a format where each transaction had two rows—one for the supplier and one for the recipient. This structure allowed us to create a unified Country column that could serve as the key for all visualizations.

To enhance clarity, we also introduced a Country Role column, explicitly indicating whether the country acted as an exporter or importer in the transaction.

## Standardization and Filtering Transactions

The dataset required significant cleaning to align with Tableau's format and ensure consistency across visualizations. For example:

- Country names were standardized to match Tableau and the World Banks's recognized format (e.g., "Brunei" was changed to "Brunei Darussalam"). This standardization was applied to over 50 countries.
- We decided to retain transactions involving non-state actors like ISIS, Anti-Castro forces, etc. in the dataset to ensure we do not exclude transactions relevant to actual countries. Even when a non-state entity is on one side of the transaction, this approach allows us to accurately represent the exporting country's contributions and observe trends in the transactions of these groups within the Country Profile and Import/Export profile.

## **Calculation of Export-Import Metrics**

- For exports, the total SIPRI TIV was summed for transactions where the country's role was “*supplier*”.
- For imports, the total SIPRI TIV was summed for transactions where the country's role was “*recipient*”.
- Additionally, a per-unit SIPRI TIV column was utilized to derive the total items ordered by dividing the total SIPRI TIV by the per-unit value.

## **Normalization and Weighted Scoring**

Since a radar chart is not natively supported as a visualization in Tableau or similar tools, it had to be replicated using scatter plots, lines, and polygons. This required several steps of data preparation:

### **1. Normalization:**

- Export and import metrics were normalized using a min-max formula. This ensured that countries across different categories—such as aircraft, naval vessels, and helicopters—could be compared on a uniform scale.
- The formula is

$$\text{Normalized Value} = \frac{X - X_{\min}}{X_{\max} - X_{\min}}$$

### **2. Weighted Scoring:**

- To calculate an overall country score, a weighted sum formula was applied to combine export and import values. The weights were intentionally biased toward exports, reflecting the strategic and financial advantages of a country's ability to export military hardware. This bias acknowledges that exporting arms not only strengthens a nation's defense industry but also enhances its global influence and economic standing.

- The formula for this was

$$\text{Country Score} = (0.57 \cdot \text{Normalized Exports}) + (0.43 \cdot \text{Normalized Imports})$$

- This approach enabled the creation of a comprehensive and visually intuitive representation of a country's military trade, integrating both exports and imports into a unified metric for analysis.

## **Highlights of Guerrilla Usability Test Results**

The guerrilla usability testing provided several valuable insights to improve the design and functionality of the tool. Key feedback highlights include:

- Year Selection Tools: Some expressed a preference for dropdowns or sliders with clear labeling to select year ranges easily.
- Conflict-Arms Trade Interaction: Many people wanted to visualize how wars and conflicts influenced patterns in arms trade over time.
- Comparative Country Profiles: Some people suggested adding the ability to view and compare profiles of two countries simultaneously.
- Radar Chart Interactivity:
  - Users desired more interactivity with radar charts, such as selecting individual categories and viewing specific items within those categories (possibly as another radar chart).
  - Concerns were raised about the radar chart's effectiveness for visualizing trade across categories, with some users suggesting bar charts as a potentially better alternative.
- Regional and Treaty Grouping: Suggestions included support for regional selection and integrating treaty organizations (e.g., NATO, ASEAN) as grouping options for analysis.
- Dynamic Global Map: Users wanted the global map to update dynamically based on selected categories for a more focused visualization.

- Search Functionality: Some people suggested adding a search feature to find countries directly in the global overview section, rather than navigating through dropdown menus.

## **Problems Encountered and modifications to plans**

- Conflict Dataset Creation: No comprehensive list of global conflicts was available, so the dataset had to be compiled manually.
- Dynamic Country Lists: The list of countries was not static due to geopolitical changes, such as the breakup of Yugoslavia into Serbia, Croatia, and other nations. Similarly, the breakup of the USSR, the combination of North and South Vietnam, the creation of South Sudan, and many more such changes did not allow our map-based approach to go back further than 1998.
- Country Comparisons: The country profile page had become overcrowded on account of all the visualizations that we added to it. This made implementing side-by-side country-to-country comparisons infeasible in the current iteration. This remains a goal for future development.
- Conflict Dataset Refinement is incomplete: Refining the conflict dataset remains a challenge. For instance, when NATO is involved in a conflict, not all member countries necessarily participate, and even those that do may play different roles. This level of detail needs to be addressed.
- Radar Chart Challenges: The radar chart, a cornerstone of the country profile section, faced significant delays in development and remains incomplete in terms of interactivity. Enhancing this feature is a key aspiration for future updates.
- Sankey Chart Development: A Sankey chart was created to visualize trade relationships between nations over time, providing a granular representation that includes partner country, year of trade, units ordered, and sub-categories of items ordered, among others.
- Stacked Bar Chart Adjustments: Stacked bar charts required modifications, such as implementing a top-N filter. Without this, visualizations for countries like the USA became cluttered with too many colors, obscuring trends.
- Trade Partnership Visualization: An initial plan to use lines between countries to show trade partnerships was abandoned due to the visualization becoming too busy and unreadable.



## Insights and Breakthroughs

### Radar Chart Implementation

The radar chart was successfully created by combining scatter plots, lines, and polygons. The process involved:

- Normalizing import, export, and overall values as described previously.
- Calculating fields such as *theta*

$$\theta = \frac{2\pi \cdot \text{Category Index}}{\text{Total Number of Categories}}$$

- Deriving X and Y coordinates using formulas like `Value*sin(theta)` and `Value*cos(theta)`.
- Connecting data points for each country using the path feature to form polygons.
- Adding a secondary duplicate field for Y coordinates, encoding it with marks (point) in Rows, and using the “Dual-axis” and “Synchronize axis” features to overlap it with the vertices of our polygon, for an accessible tooltip.

## Year Slider and Conflict Visualizer

A year slider and conflict visualization were successfully implemented on the global overview page, allowing users to view all conflicts in one place, in the time period that they wish to analyze. Users can also filter the conflicts by clicking on individual countries. Conflicts involving a country outside its territory were also visualized. For instance, clicking on Australia displayed its participation in the Iraq conflict against ISIS.

## Sankey Chart Optimization

The Sankey charts were effective in visualizing higher-order trends like which years saw more or less trade, which sub-category saw more / less activity, and which partner was most / least relied upon.

Besides this, to add more usability and functionality, a new filter for country was added. Now it is possible to view the import-export relationship between one nation and a selected list of nations. Moreover, the tooltips that appear on hovering over a trade item were populated with relevant information such as the sub-category of trade, the value of each individual unit of trade (based on SIPRI TIV), and the number of items traded.

## Dashboard Blank Spaces

Many countries lacked arms export data, resulting in blank sections on their dashboards. While it was something we could have ignored and not shown, we kept it to show how concentrated the arms export space is.

## **Critical Evaluation of Success**

- The dashboard was designed to serve as an informative tool for journalists and other interested parties, providing a broad and accessible overview of global military trade. In this regard, it has successfully achieved its goal. However, the project falls short of meeting the demands of keen researchers who require more granular data, cross-country comparisons, and greater interactivity in visualizations. Addressing specific details about particular weapons or systems and refining the conflict list to include involved parties are areas that could be tackled in a longer-term project.
- The global overview page emerged as a useful dashboard. It reveals export and import values visually through geographic representation, and allows users to apply various filters and access a list of conflicts alongside a map and a bar chart, all within one interface. This composite view offers significant value for

researchers seeking a high-level understanding of global military trade and conflict dynamics.

- The country profile integrates a country's export-import trade data with its partner countries and military personnel/GDP figures into a single dashboard. This combined internal and external perspectives into one view, making it highly useful for analysis. However, there remains room for improvement. Enhancements such as increasing interactivity in the radar chart, making line graphs more information-dense, and improving the readability of stacked bar charts (e.g., labeling colored sections with country names) would significantly enhance the user experience.
- The Sankey chart provided a detailed visualization of trade, including exports and imports, but it could be further refined. Adding a top-N filter to focus on trade relationships with the top partner nations and improving the readability of smaller axes elements would make the chart more accessible and impactful.
- A country comparison page could not be implemented in this version, but it remains an area of interest for future development.
- Extending the visualization to cover data from 1950 onward poses challenges, such as incorporating regions like the USSR into the map and addressing the complexity of areas like the South China Sea with multiple stakeholders. Tableau's current limitations, such as the inability to select water bodies on a map, add to this challenge. Further work on this project could look to overcome this challenge.
- Finally, the conflict dataset requires deeper refinement. While it currently covers the most recent 25 years, extending it to include earlier years and capturing detailed participation data (not just treaty organizations but individual countries' roles) would significantly enhance its utility. These improvements would help create a more comprehensive and insightful tool for global military trade and conflict analysis.

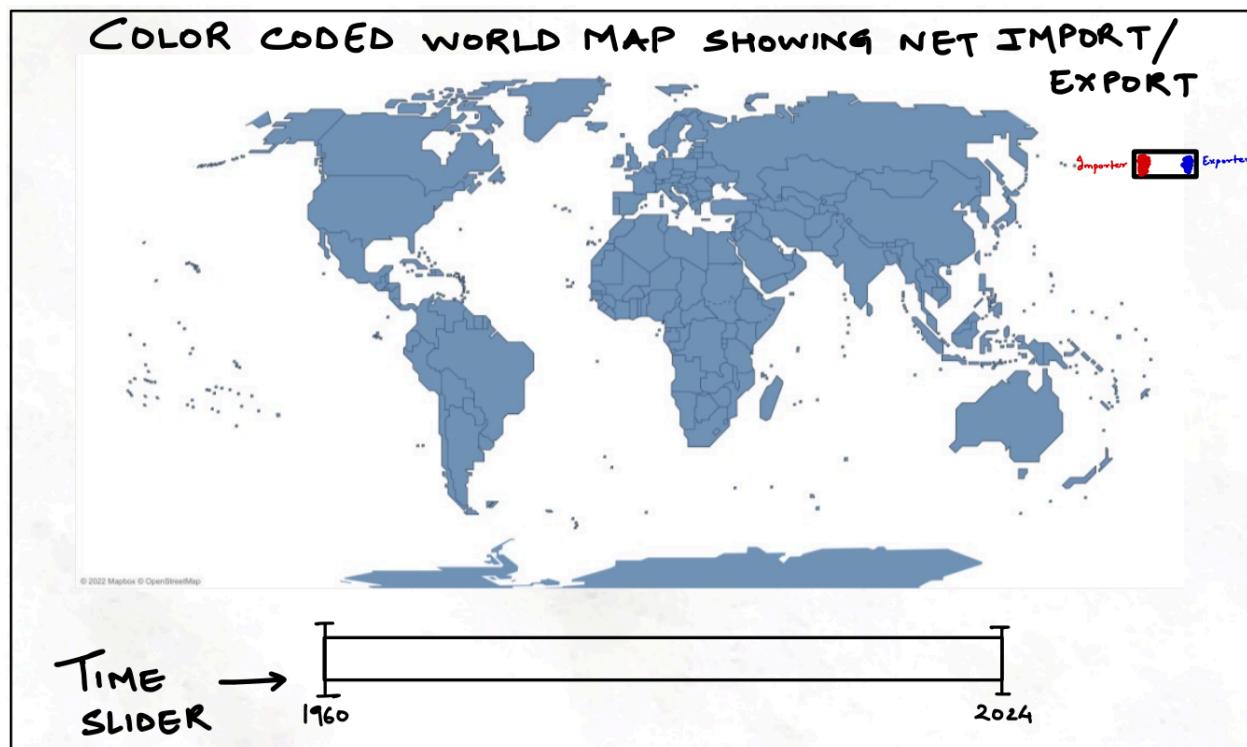
## Concepts used

- The dashboard relies heavily on View Manipulation and the sub-concepts of Select, Navigate, Coordinate, and Organize as described by Heer and Schneiderman in their paper Interactive Dynamics for Visual Analysis. Starting on the map the user is able to select countries to view the conflicts that the country has been involved in and their top trade partners. They can then navigate

to that country's specific Country Profile page to get more detailed information about that country's high-level patterns, and then they can go to the Import/Export page for further deep-dive analysis of the country's relationships. All of the windows are organized and connected through a central navigation menu.

- We attempted to structure our dashboard in an overview and filter down the details on the demand structure as recommended by Schneiderman and discussed in class. The intended home page of our dashboard was the world map, which provided a high-level overview of each country's role as an exporter or importer of weapons. We also provided the conflict information on this page to provide a jumping-off point for users to start asking questions. The user could then filter down to an individual country by navigating to the country profile to get a more specific view of that country's weapons transactions and history. Lastly, the user could get very specific, we'll call these our details on demand, in the Import/Export dashboard to see the specific breakdowns of interactions between countries over time by category.
- We used brushing and linking as described by Heer and Schneiderman on the map page. Selecting a country on the map filters the list of conflicts to the side of the map. There are a large number of conflicts by default, so being able to select a country, see its relevant conflicts, and also view its tooltips of top partners allows the user to go quickly from a high-level map view to basic information about the specific country.

## Appendix (Design Sketches from C2)

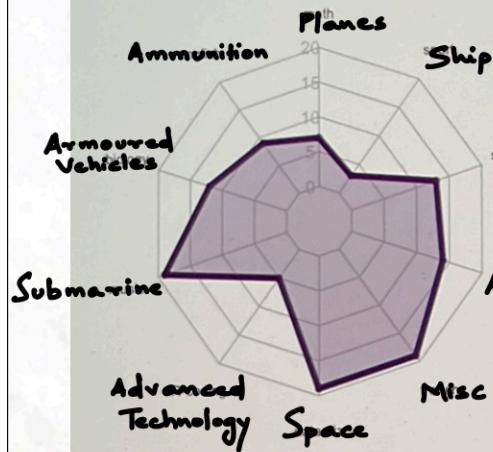


COUNTRY NAME

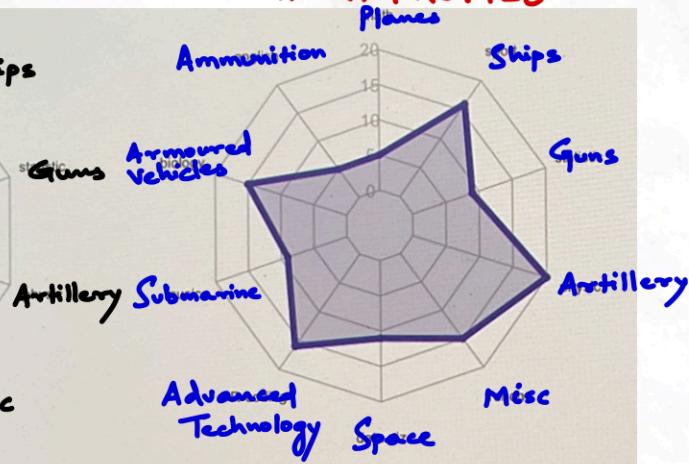
Choose Country ▾

Choose Time period ▾

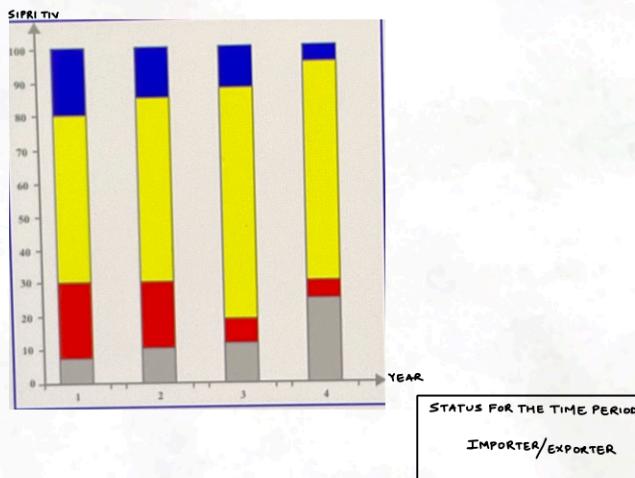
EXPORT PROFILE



IMPORT PROFILE



TOP EXPORT PARTNERS



TOP IMPORT PARTNERS

