Fermilab

The Web as the Primary Control System User Interface

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ICALEPCS - User Interfaces, Perspective, and Experience

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Why Web Technologies?*

- All major browser cores track standards
  - Bleeding-edge JavaScript
  - Support latest HTML/CSS specs
  - Great developer tools
- JavaScript engines are fast
- Benefit from huge collaboration in JS ecosystem
  - Companies have a vested interest in the web
- Apps are extremely portable
  - Across browsers, operating systems, and form factors (i.e. desktop and mobile devices)
- Progressive Web Apps

*We have a JavaScript module providing full bandwidth to our control system

Built-in Developer Tools

- Debuggers
  - Code debugger (breakpoints, single-step, etc.)
  - Layout debugger (manipulate DOM tree.)
  - Style debugger (tweak CSS attributes.)
- Profilers
  - Code profiler
    - Shows hot spots
    - Measures function execution time
    - Measures GPU rendering time
  - Memory profiler
    - Monitor heap and garbage collector behavior
  - Network profiler
    - Show network packet timing and contents
    - Measures load time of page resources

TypeScript

- “Transpiler” created by Microsoft
- Uses JavaScript syntax with extensions
  - Adds type annotation to function arguments, variables, and object properties
  - Adds new types to language (i.e. tuples)
- Converts TypeScript to JavaScript
  - Annotations are stripped
  - During conversion, extensive type analysis is done
- Finds many silly mistakes at compile-time
- Many 3rd party libraries include TypeScript declaration files
- Highly recommended

React (w/JSX)

- Light-weight JavaScript library to build “components”
- Components are stand-alone JavaScript modules that:
  - Render themselves as HTML elements
  - Manage state associated with their elements
- Components containing components build complex behavior
  - Applications are a tree of nested components with glue logic to manage state
- JSX allows HTML-like syntax in source
  - Gets converted into equivalent DOM calls
  - Expressions can be injected in generated elements

React Example

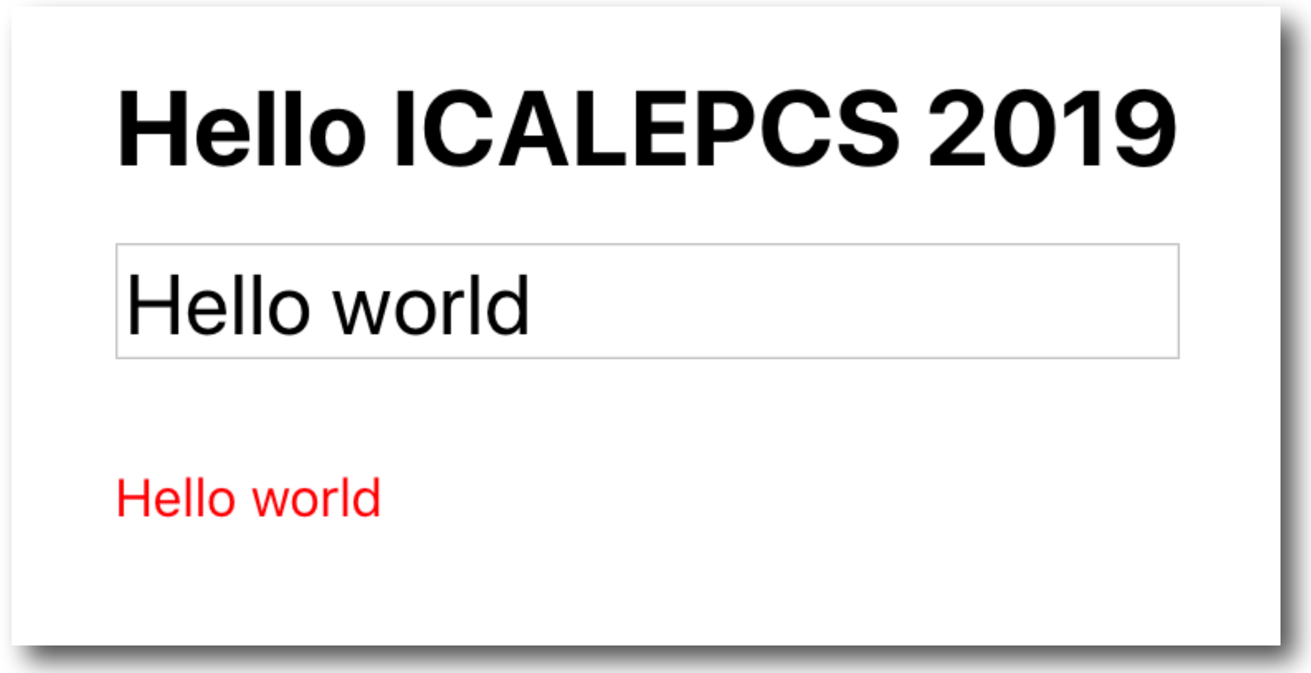
```
import React, { useState } from 'react'
import './ReactiveInput.css'

interface ReactiveInputProps {
    label: string,
    maxLength?: number
}

const ReactiveInput: React.FunctionComponent<ReactiveInputProps> =
    ({ label, maxLength = Infinity }) => {
        const [currInput, setCurrInput] = useState('');

        return (
            <div className='reactiveInput'>
                <label htmlFor='reactiveInput'>{label}</label>
                <input
                    type='text'
                    name='reactiveInput'
                    value={currInput}
                    onChange={(event) => {setCurrInput(event.target.value)}}
                />
                <p className={currInput.length > maxLength ? 'invalid' : ''}>
                    {currInput}
                </p>
            </div>
        );
    };

export default ReactiveInput;
```



Hello ICALEPCS 2019

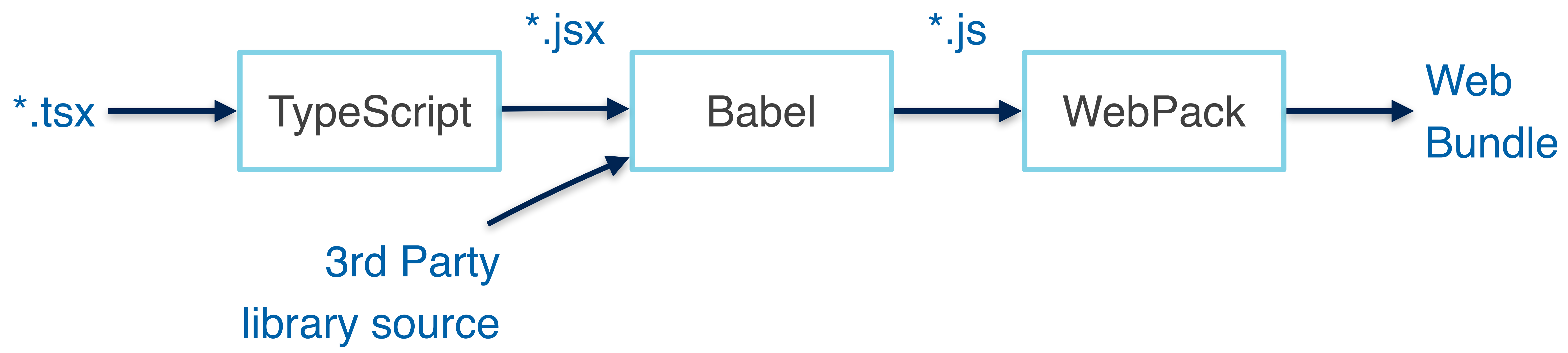
Hello world

Hello world

```
ReactDOM.render(
    <ReactiveInput
        label='Hello ICALEPCS 2019'
        maxLength={10} />,
    document.getElementById('root')
);
```

Available at
https://github.com/fermi-controls/icalepcs2019

Development



- Not typical, familiar edit/compile/link cycle
- Build tools have a different focus
  - Compatibility between browsers
  - Minimizing final bundle size
    - Dead code elimination
    - Remove comments and unnecessary whitespace
    - Shorten identifier names

Example - Charts

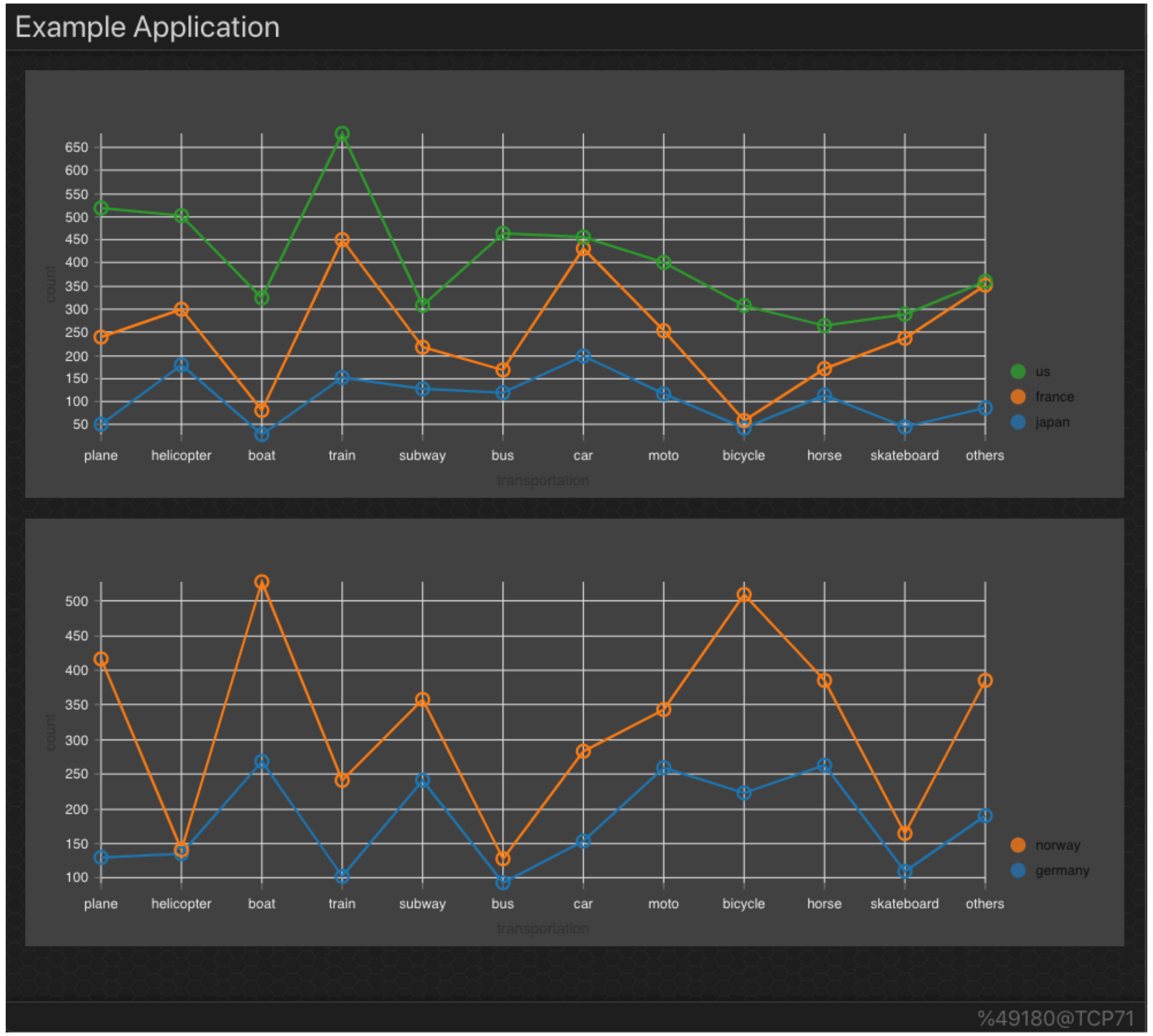
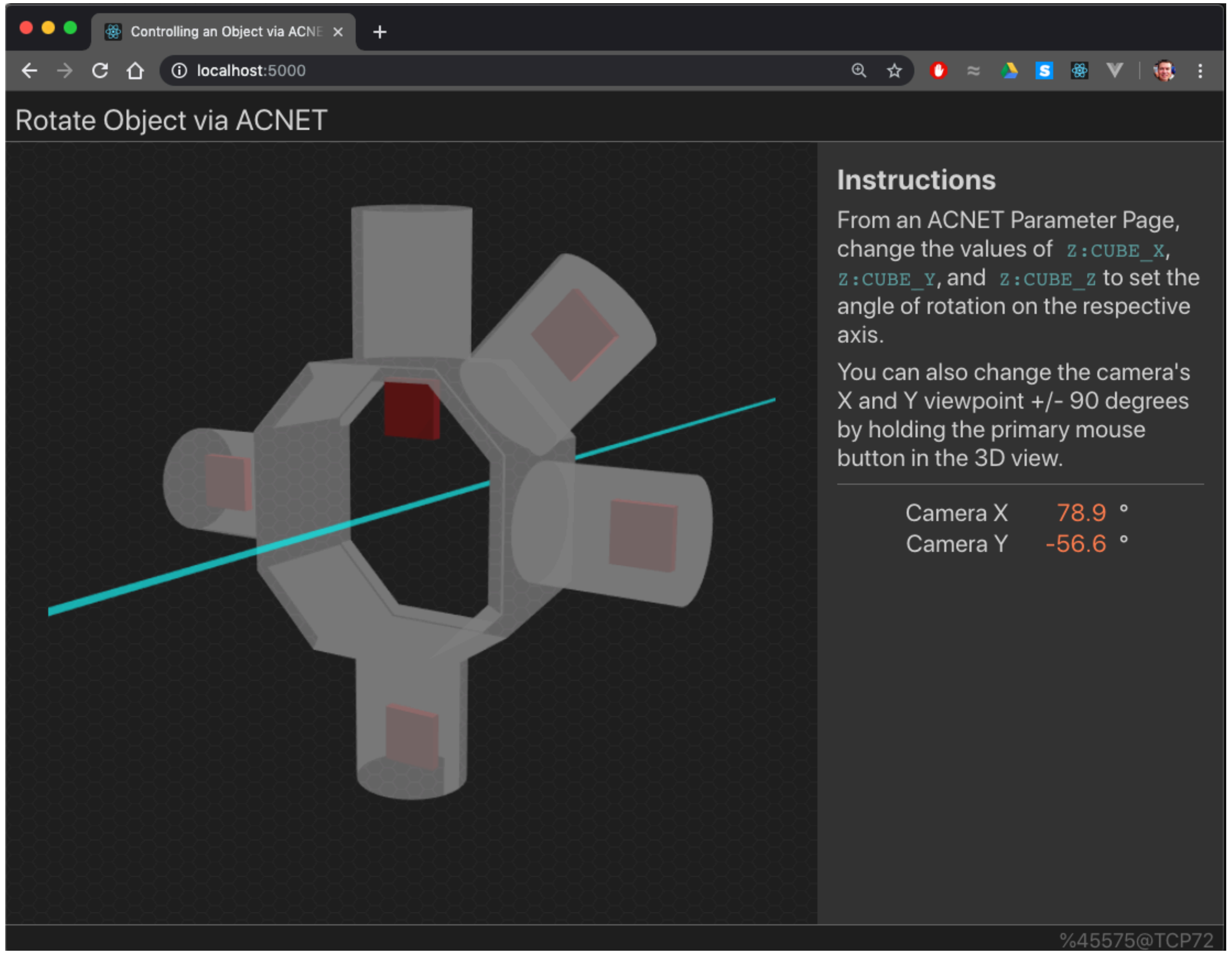


Chart demo using Nivo Charts (https://nivo.rocks/)

Example - 3D Modeling



Rotate Object via ACNET

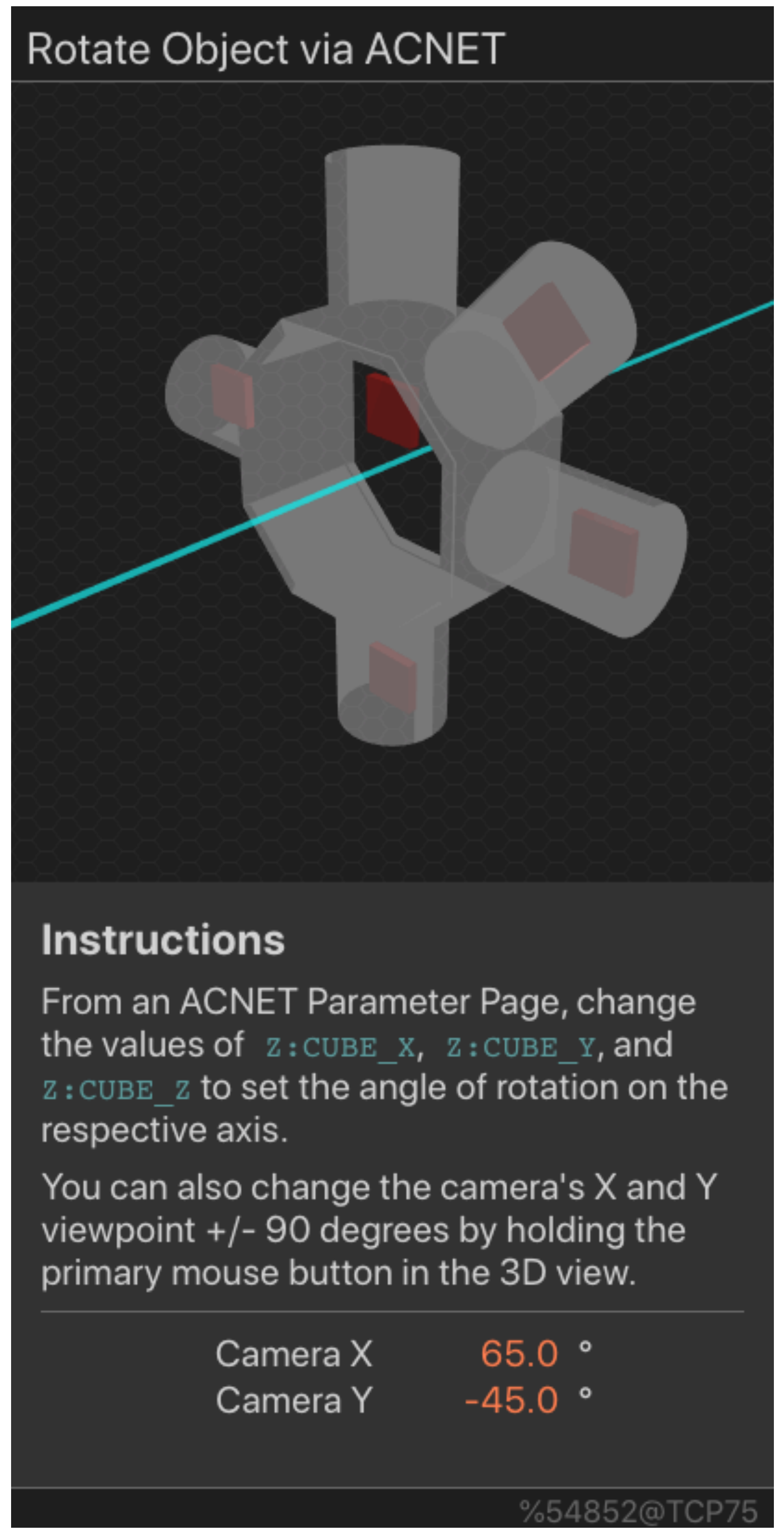
Instructions

From an ACNET Parameter Page, change the values of `Z:CUBE_X`, `Z:CUBE_Y`, and `Z:CUBE_Z` to set the angle of rotation on the respective axis.

You can also change the camera's X and Y viewpoint +/- 90 degrees by holding the primary mouse button in the 3D view.

```
Camera X    78.9 °
Camera Y   -56.6 °
```

%45575@TCP72



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```
Camera X    65.0 °
Camera Y   -45.0 °
```

%54852@TCP75

WebGL demo using ThreeJS (https://threejs.org/)

Still To Do

- Deployment details
  - Setting up an area to host applications
  - Build system that can properly add new apps
  - Directory / Index page to help find available apps
- Security
  - Access currently requires client to be on-site or using VPN
  - Need authentication credentials for settings, etc.
    - Two-factor / YubiKey?
    - Kerberos / GSSAPI?

Conclusions

- Modern browsers provide a powerful and compelling environment for hosting acceleration applications.
  - There are comprehensive development tools in browsers to handle all aspects of web development.
- Frameworks provide a professional, intuitive experience for users, and they hide browser differences from programmers.
- Tools, like TypeScript and JSX, move many run-time issues to compile-time, making it easier to produce correct code.
- All these technologies are backed by huge companies (Google, Apple, Microsoft, Facebook, …) that have a stake in the success of the web.