Safety v. resilience

Christchurch Earthquake, 2011 (Hopkins & Sablyak, Johnson)

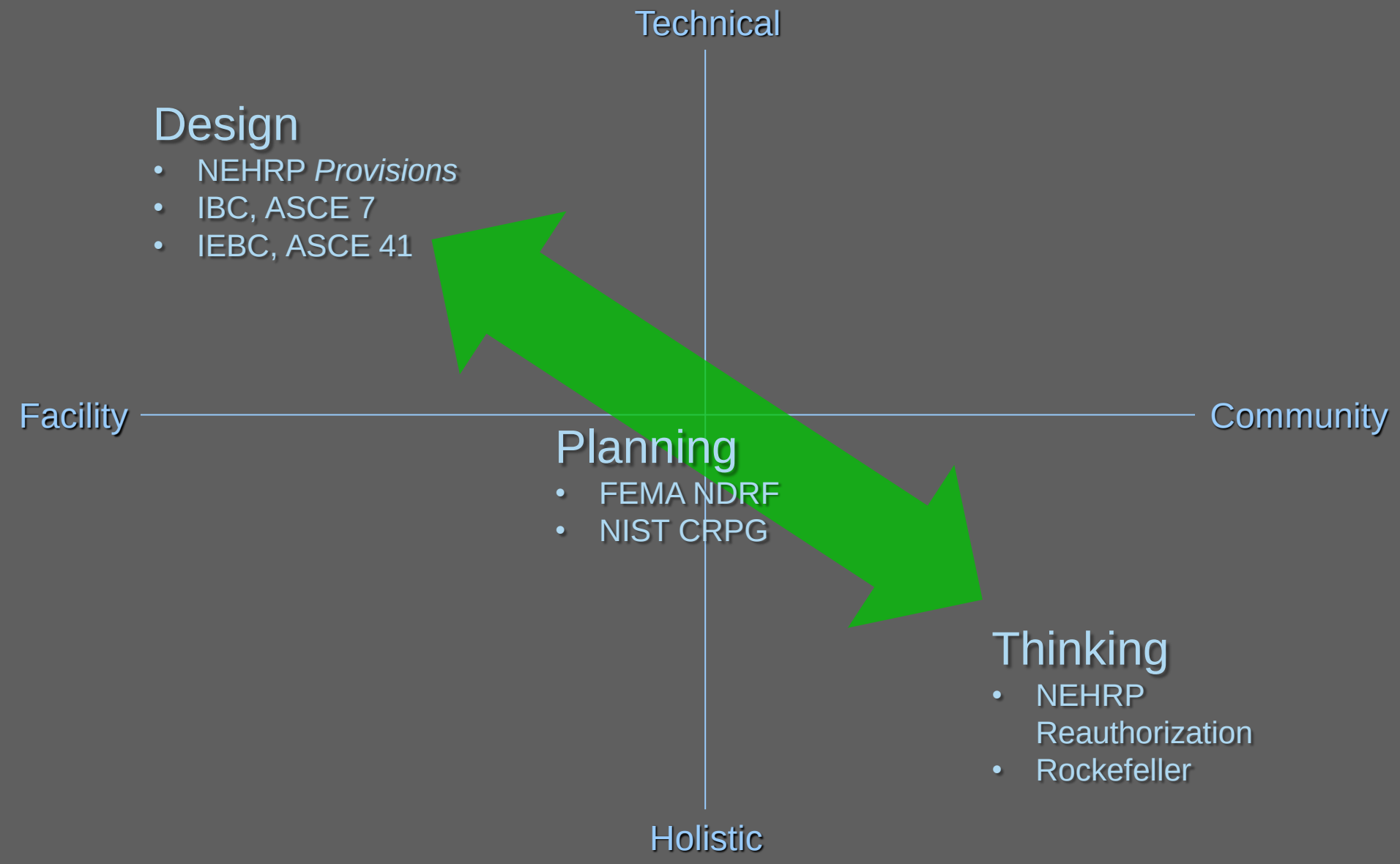
Resilience: 4 essential ideas

- An attribute of organizations, not buildings
- Focused on function, not just safety
- Measured over time, not by immediate damage
- Relates mostly to natural hazards

- *So how do we design for it?*

Resilience in context

Resilience field



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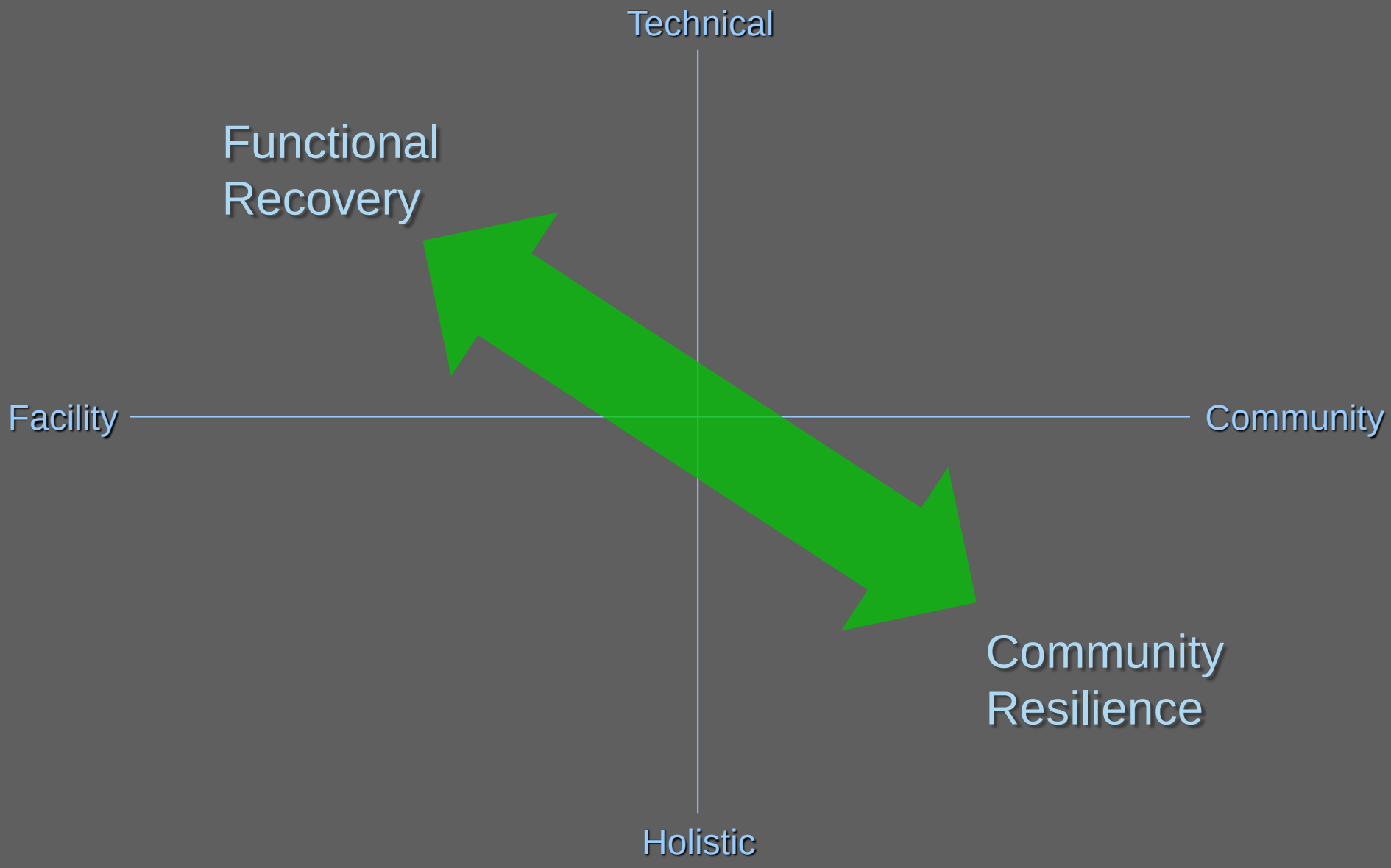
FR:Building :: CR:Community



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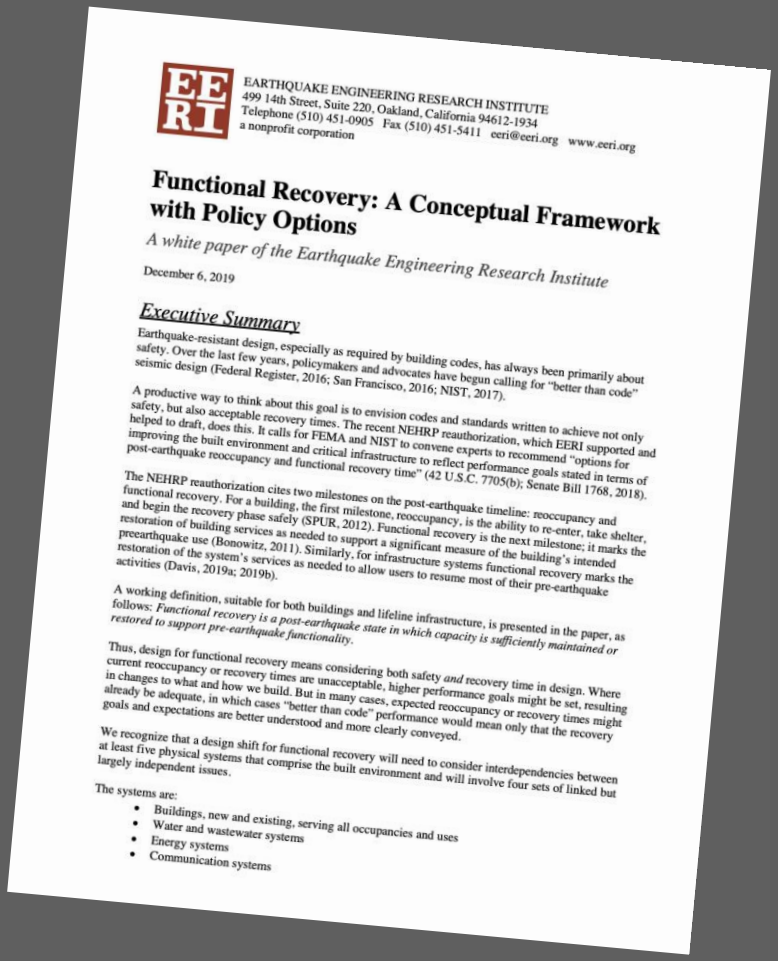
Developing the FR concept

- Four issue areas
  - Definitional
  - Policy
  - Technical
  - Implementation
- All are related, but each will progress independently



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Functional Recovery: A Conceptual Framework with Policy Options

A white paper of the Earthquake Engineering Research Institute

December 6, 2019

Executive Summary

Earthquake-resistant design, especially as required by building codes, has always been primarily about safety. Over the last few years, policymakers and advocates have begun calling for "better than code" seismic design (Federal Register, 2016; San Francisco, 2016; NIST, 2017).

A productive way to think about this goal is to envision codes and standards written to achieve not only safety, but also acceptable recovery times. The recent NEHRP reauthorization, which EERI supported and helped to draft, does this. It calls for FEMA and NIST to convene experts to recommend "options for improving the built environment and critical infrastructure to reflect performance goals stated in terms of post-earthquake reoccupancy and functional recovery time" (42 U.S.C. 7705(b); Senate Bill 1768, 2018).

The NEHRP reauthorization cites two milestones on the post-earthquake timeline: reoccupancy and functional recovery. For a building, the first milestone, reoccupancy, is the ability to re-enter, take shelter, and begin the recovery phase safely (SPUR, 2012). Functional recovery is the next milestone; it marks the restoration of building services as needed to support a significant measure of the building's intended preearthquake use (Bonowitz, 2011). Similarly, for infrastructure systems functional recovery marks the restoration of the system's services as needed to allow users to resume most of their pre-earthquake activities (Davis, 2019a; 2019b).

A working definition, suitable for both buildings and lifeline infrastructure, is presented in the paper, as follows: *Functional recovery is a post-earthquake state in which capacity is sufficiently maintained or restored to support pre-earthquake functionality.*

Thus, design for functional recovery means considering both safety *and* recovery time in design. Where current reoccupancy or recovery times are unacceptable, higher performance goals might be set, resulting in changes to what and how we build. But in many cases, expected reoccupancy or recovery times might already be adequate, in which cases "better than code" performance would mean only that the recovery goals and expectations are better understood and more clearly conveyed.

We recognize that a design shift for functional recovery will need to consider interdependencies between at least five physical systems that comprise the built environment and will involve four sets of linked but largely independent issues.

The systems are:

- Buildings, new and existing, serving all occupancies and uses
- Water and wastewater systems
- Energy systems
- Communication systems

What we can do now

	Definitional	Policy	Technical	Implementation
Design for FR objectives	●		●	
Retrofit for reoccupancy	●		●	
Resilience-based inventory	●	●		
Resilience planning & policy		●	●	●
Local code amendment		●	●	●
Supplemental strategies	●	●		●
Recovery-focused research	●	●	●	
Model code development	●	●	●	●

Design for FR objectives

181 Fremont, SF, 2018
UCSF Mission Hall, 2014

Casa Adelante (1296 Shotwell), SF, 2019
Beaverton schools, 2015

Functional Recovery

What it means to design for community resilience

Available as a webinar on YouTube. Search for "EERI Bonowitz."

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