



FIF Proposal: Closing Design Cycle

Professor Aleksandar Pavic

Presented at 4th Future Infrastructure Forum
Cambridge, 5 September 2012

The University of Sheffield
Department of Civil and Structural Engineering
Vibration Engineering Section

Background and main ideas

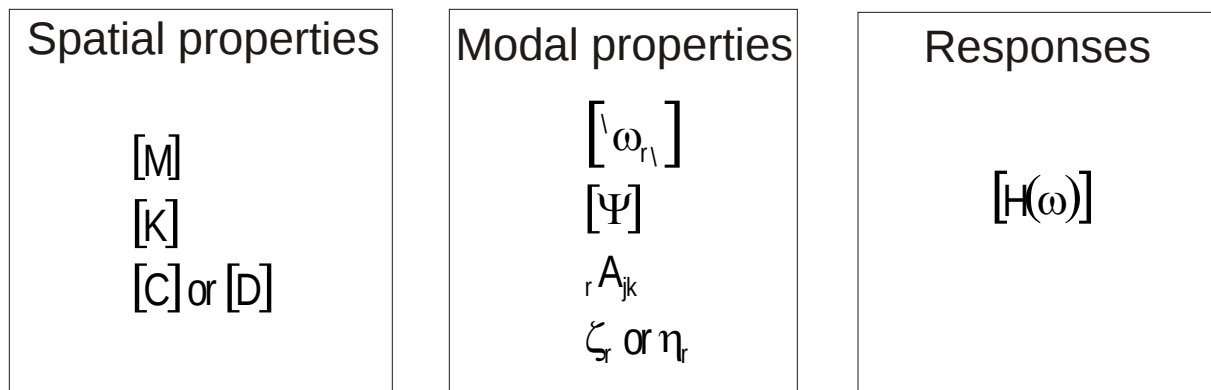
- Start from scratch
 - In Sheffield, and not Bristol
 - In 1993 when starting PhD
- Get out of laboratory
 - Real structures are our laboratories
- Transfer technology
 - Mechanical and Aerospace Engineering
 - Modal and dynamic testing
 - FE model updating
 - Apply to different scale problems
 - Civil engineering structures
- Focus on niche but promising area
 - Vibration serviceability
 - Human-induced dynamic loading



Technology: The Main Idea



Theoretical route

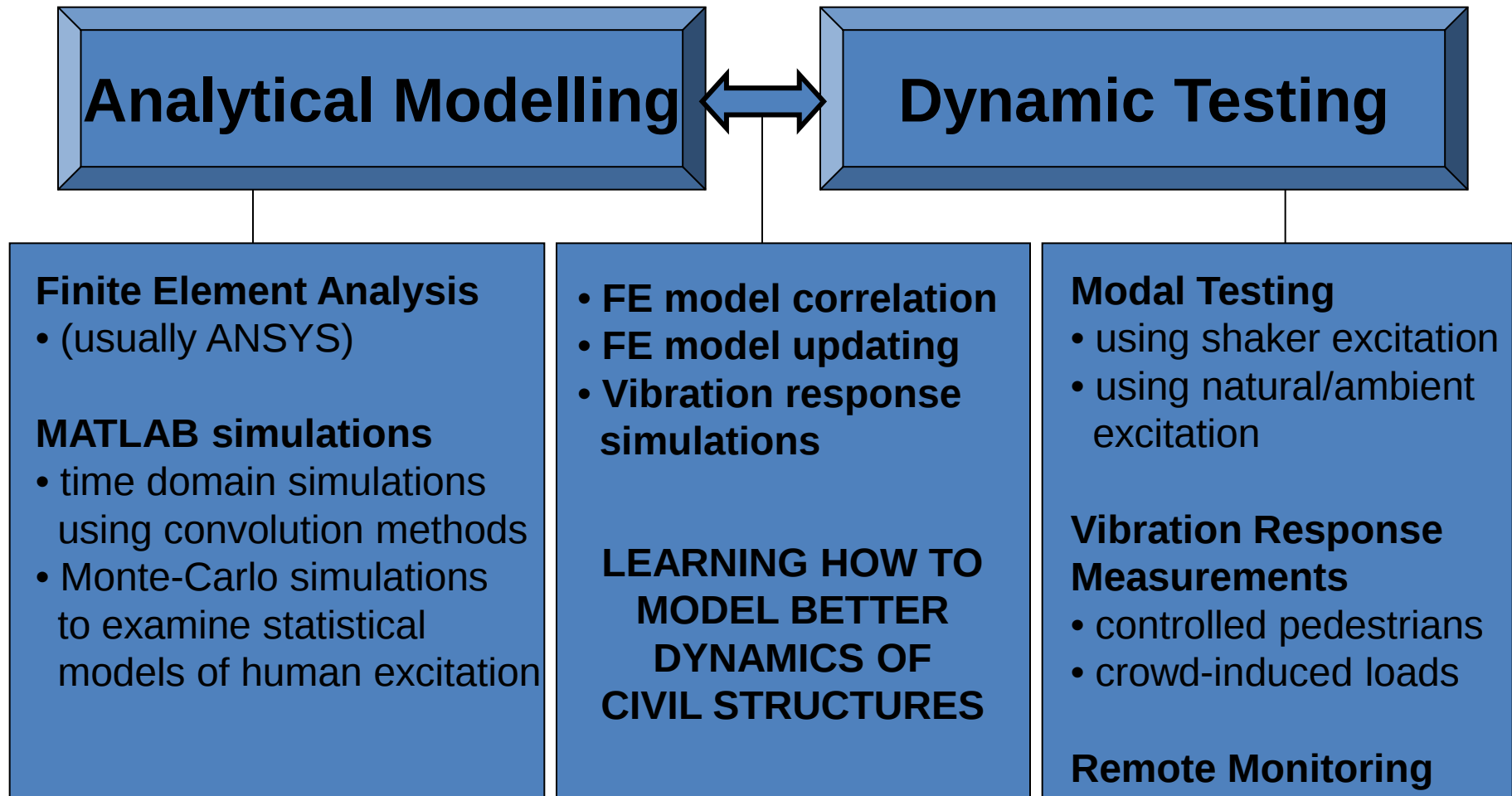


Experimental route

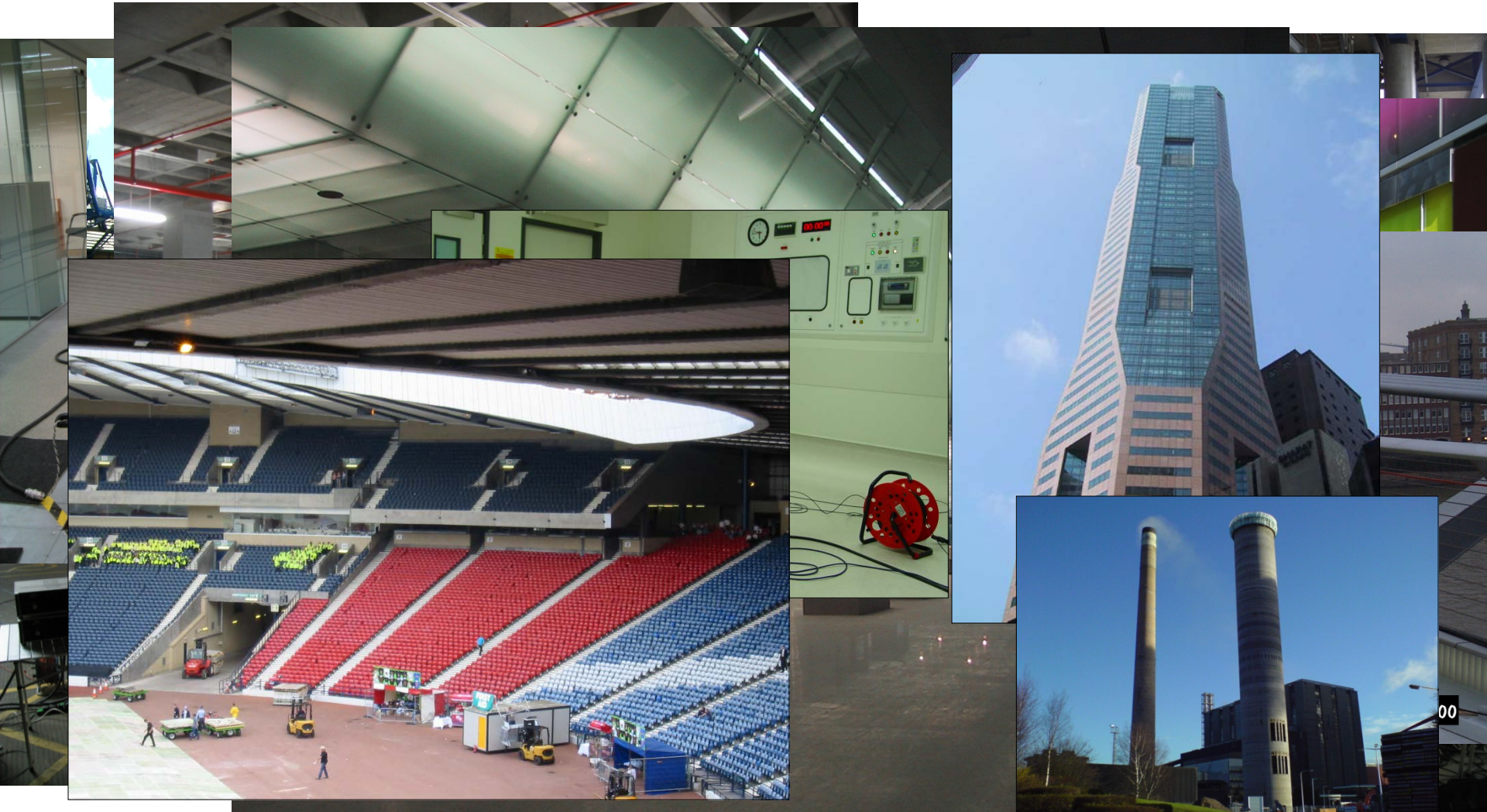


RESEARCH AND ACHIEVEMENTS

Our approach to full-scale structural performance problems



Some of our worldwide laboratories...



Let's get organised a bit...



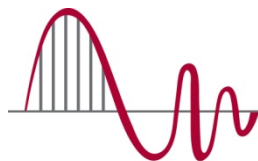
Worldwide uniqueness

Testing databases

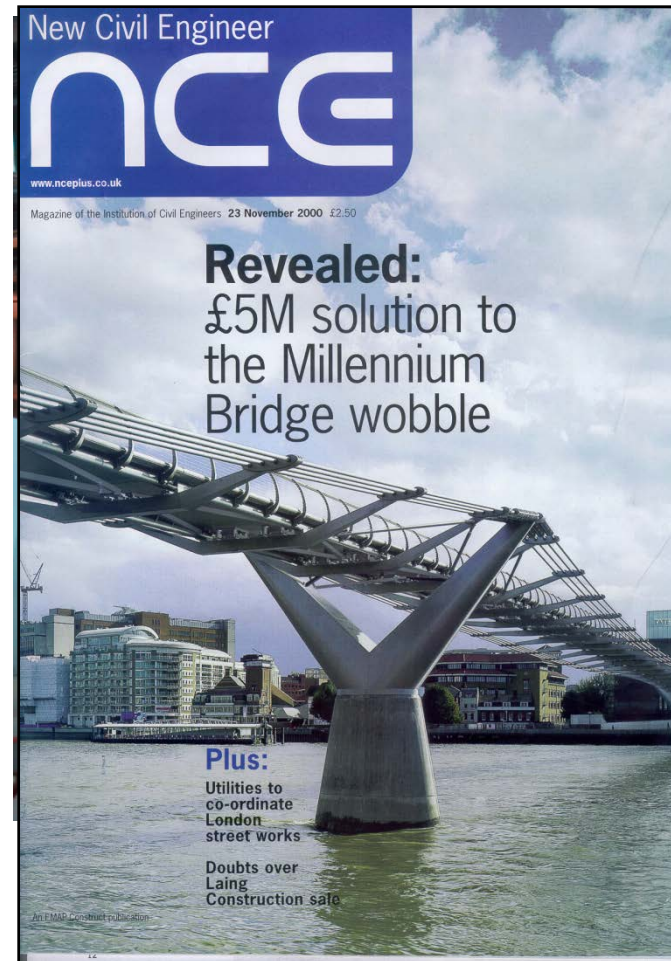
- VES has largest databases of full-scale test results worldwide
 - Over 200 full scale tests
 - Any dynamic test of a large structure described in English we can do
 - Databases
 - Floor dynamic test results
 - Stadia test results
 - Directly measured human-induced dynamic forces
 - Treadmill walking
- Nowadays
 - Much easier to measure than to model
 - We do testing instead of modelling of existing structures
 - Much easier for us
 - Much more reliable results
 - Simulations based on modal testing and not modal analysis results

Commercial application of our work

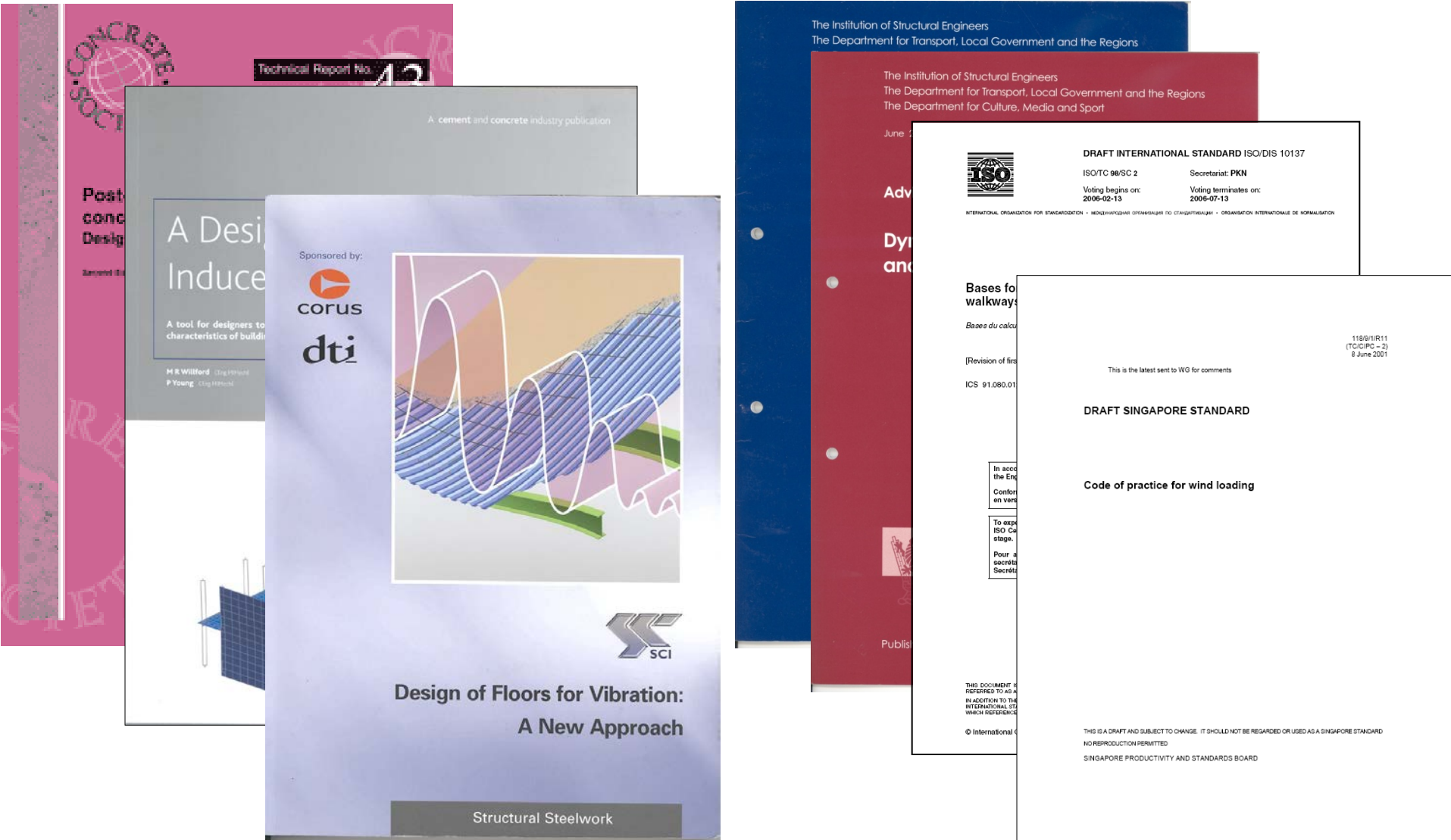
- Entrusted to organise and execute politically and commercially sensitive dynamic testing of:
 - The London Millennium Bridge
 - Gatwick Airbridge
 - The new Diamond synchrotron project
- Incorporated FSDL in November 2008



FULL SCALE
DYNAMICS LTD
REAL WORLD CONDITIONS
REAL WORLD SOLUTIONS



Codified application of our work





RESEARCH IDEA

Problem:

What do you do with research findings?

Classical route

- Publish
- Hope that it will end up in design practice
- Takes a long time
 - If ever, to get codified
- Data usually ends up covered by confidentiality agreements
 - Professional and legal framework and culture dictates that

FIF-funded route

- Create
 - Systematic shortcuts to design guidelines
 - Protocols that industry and codifying bodies can easily adopt to make use of measured data
 - For future designs
 - For design guidelines
 - Easy ways to benefit from measurements
 - Can we change what we currently have

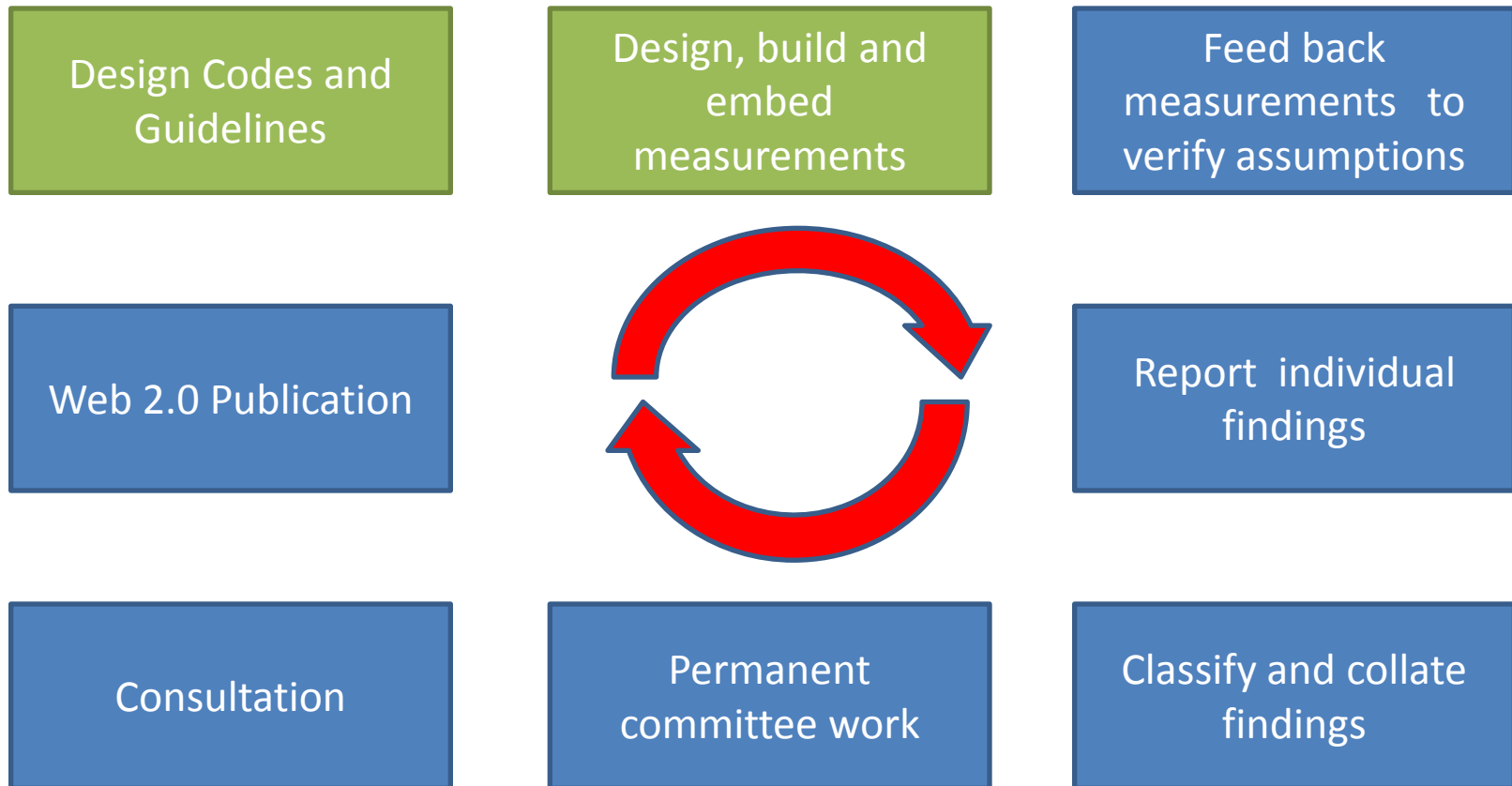
Partners

- Two universities
 - Sheffield
 - Bristol
- Two consultants
 - Atkins
 - Parsons Brinkerhoff
- Organisations issuing codes and design guidelines

EPSRC FIF: Closing structural design cycle by testing and monitoring

- Problem:
 - We design, we build and – in principle - we don't know how it behaves after it is built
 - We don't measure and know little
- Civil engineering design is based on:
 - Design codes of practise and design guidelines
 - Producing one off prototypes
 - Not mass production prototyping and testing
 - Problems:
 - Lag behind state of the art
 - Difficult to update
 - Conservative
 - Unreliable?
 - Typical development cycle
 - Committee work
 - Wise guys meet
 - » Papers and experience
 - » Assumptions rather than facts
 - » Conservative approach
 - » Unreliable
 - Drafts
 - Consultation
 - Use
 - Call for update
 - Wise guys meet again
- Measurement technology
 - Rapidly developed
 - last 10 years
 - Cheap and available
 - Not normally part of structural design
 - When used, technology benefits hugely:
 - Particular projects
 - Research community
 - Conference organisers
 - Publishers of research papers
 - Wise guys
 - Future design guidelines
- Opportunity
 - Measure much more
 - Embed in normal design and construction
 - Establish feedback from measurements to design
 - Embed in normal design
 - Regulation
 - Future design guidelines
 - Regular updates
 - Data flow:
 - Design
 - Measure,
 - Feedback

Closing the design cycle



Crucial FIF contribution

- What are other useful examples?
 - Temperature effects in bridges?
 - Unwarranted assumptions.
 - Identify:
 - Problems
 - People
 - Projects
 - Wise guys
 - Committees
 - Codes/guidelines
- Embedded measurements feed into
 - Digital model for PARTICULAR structures
 - Better decision making
 - Improved design codes/guidelines for ALL structures
 - Better decision making