

The Development of GNSS (and other survey technologies) for High Rise Building Surveying



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History



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- 1785 a telescope theodolite developed
- Used in 1787 to tie in French-English triangulation system
- 1926, velocity of light determined by measuring time of flight of light
- 1929, suggested this could be used to measure distance
- 1948-1953 AGA Geodimeter

Since then....



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- Total stations, reflectorless TS, laser scanners, digital photogrammetry, LIDAR, GPS, GNSS, GBSAR etc etc etc etc
- Software, and more software
- CPD required for continuous updates and training



Continued Professional Development

- After IPD – Initial Professional Development
- CPD is required – Continuing Professional Development
- Maintains knowledge and expertise
- Keeps engineer up to date

- www.FIG.net

- Various regional and international meetings
- Repository of information on the FIG www
- Sharing good practices and developments

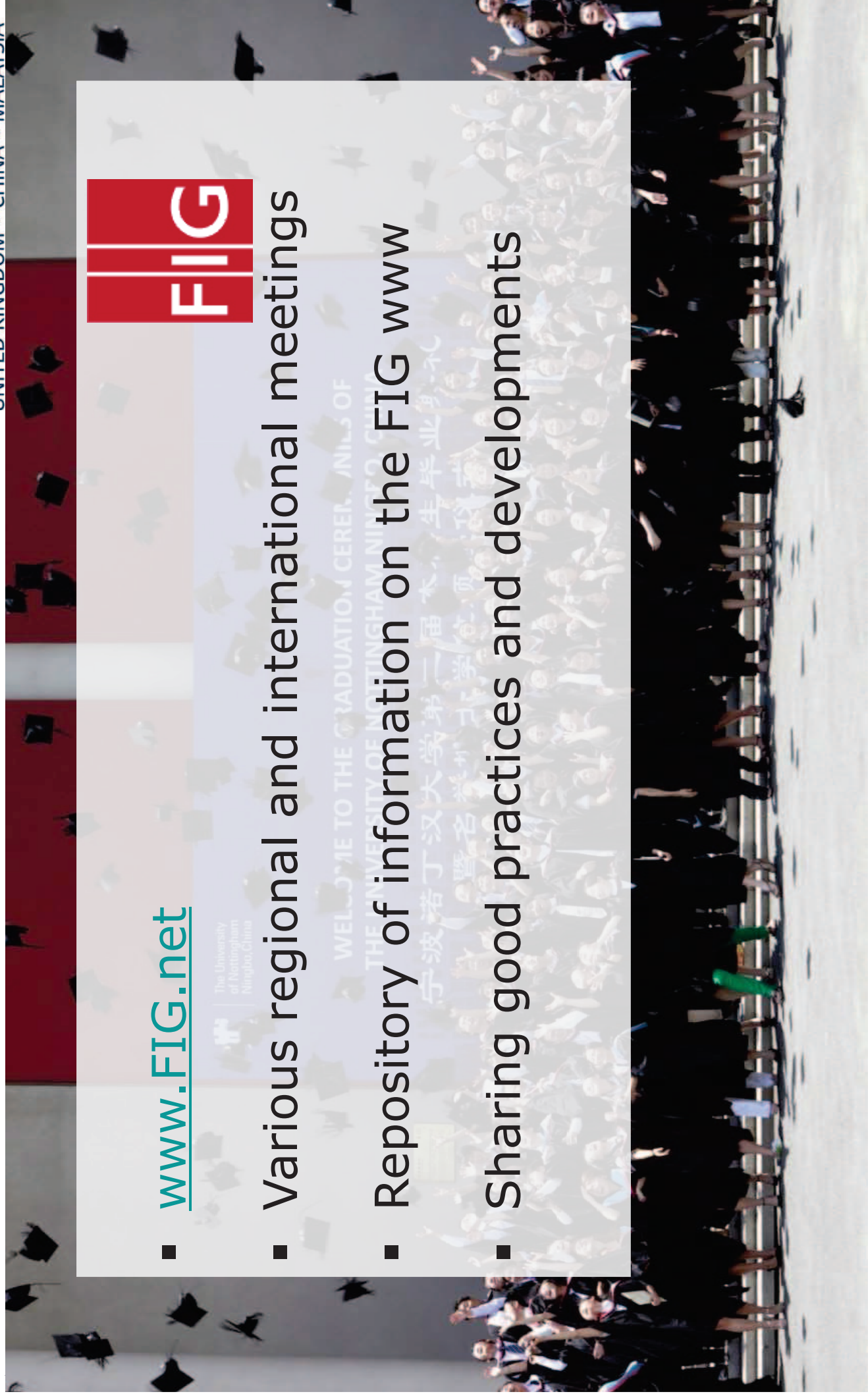


FIG Commission 6

- Working Group 6.1 – Deformation Measurements and Analysis
- Working Group 6.2 – Engineering Surveys for Construction Works and Structural Engineering
- Working Group 6.3 – Machine Control and Guidance (MCG)
- Working Group 5.5 – Ubiquitous Positioning Systems (Commission 5 has lead and work plan is described in Commission 5 work plan)



- Vast Development underway 正在高速发展
- High Speed Train network 高铁网络
- Highways 高速公路
- Power lines 电网
- Structures, tall buildings, dams 高楼大厦, 堤坝
- Shipping 航运

Mining 采矿



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- Open pit and deep mining 开深井采矿
- GNSS technology difficult in open pit 单靠全球导航卫星系统开井有难度
- Integration with other systems eg Locatalites 需要结合其他系统，如地面定位卫星信号

Middle East

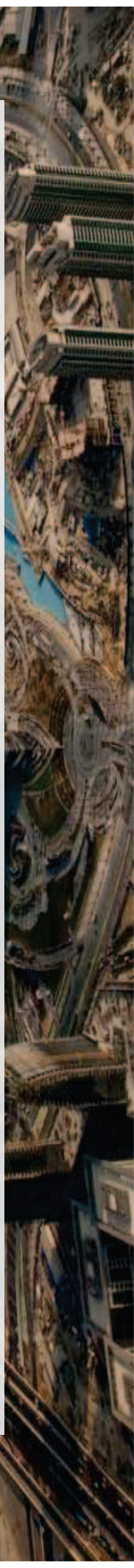
中东



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- Lots of construction related work 大量建筑类工作
- Tall buildings 高楼
- Burj Khalifa Building, Dubai 迪拜哈里发塔
- 829.84m tall 高达829.84米



Middle East

中东



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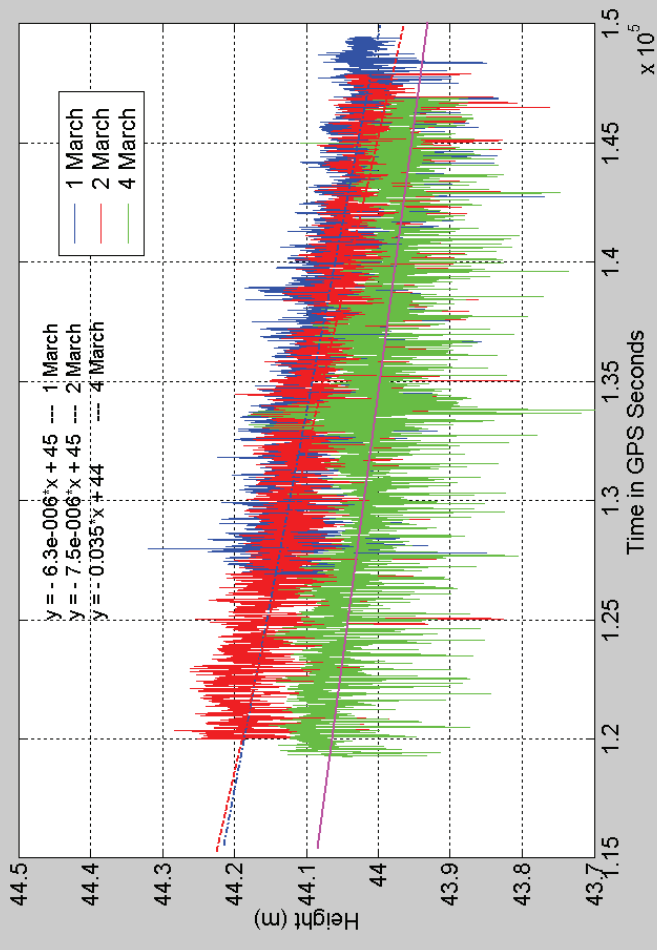
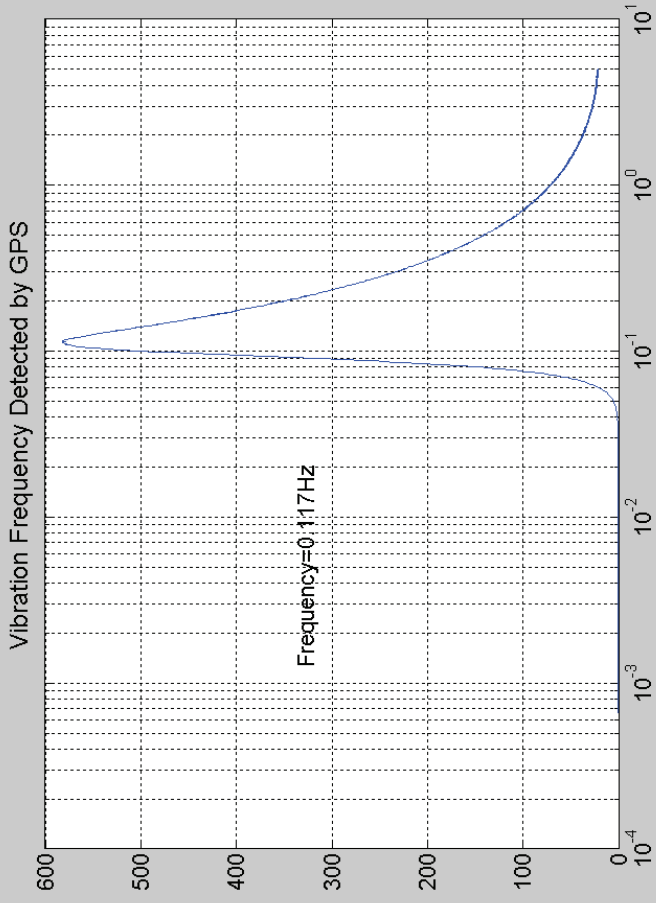
- New building planned for Qatar计划在卡塔尔新建的大楼
- 1001m tall Kingdom Tower 高达1001的吉达王国塔
- Difficult to use traditional total station approach to monitor verticality during construction 很难使用传统的全站仪来检测建筑时是否垂直
- New methods include GNSS and Tilt Sensors 新方法包括全球导航卫星系统及倾斜感应器



Bridge Monitoring

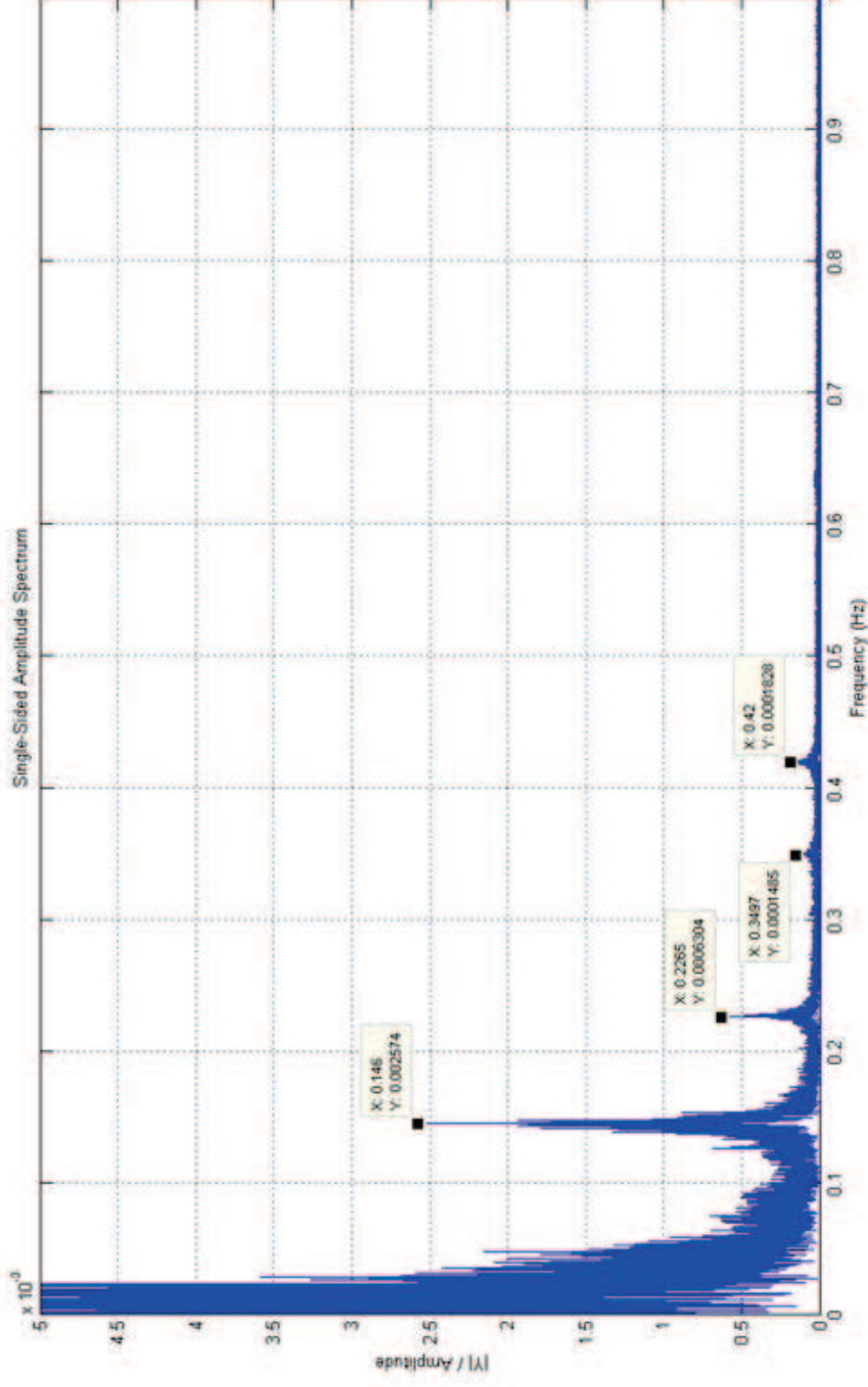
桥梁检测

- Structural Health Monitoring Systems 建筑健康监测系统
- Examples include Tsing Ma Bridge, Stone Cutters Bridge, Hong Kong 马大桥、昂船洲大桥 范例包括香港的青马大桥、昂船洲大桥
- Incheon Bridge South Korea 韩国的仁川大桥
- Monitoring could enhance the life of the structure 此监测能延长建筑物的寿命





- Location B spectral analysis B点光频谱分析





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Technical Developments 技术发展

- SAR, GBSAR 合成孔径雷达
- Laser scanning 激光扫描
- GNSS 全球导航卫星系统
- Pseudolites and localities 伪卫星和地面定位卫星
- Robotic Total Stations 伺服驱动全站仪
- Need to keep abreast of developments 各种技术发展需要并驾齐驱



SAR 合成孔径雷达

- Synthetic Aperture Radar 合成孔径雷达
- Data in existence for many years 数据存在已经很多年了
- Good method for deformation monitoring of large areas 大面积变形监测的好方法
- Includes mining subsidence, land subsidence 包括矿地下陷、地面前陷

GBSAR



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- **Ground Based Synthetic Aperture Radar 基于地面的合成孔径雷达**
- **New Development 新发展**
- **1/10mm to 1/100mm**
- **Up to 100Hz 达到100赫兹**

Current and Planned Navigation Satellite Systems

Global 国际性系统

系统



GPS



GLONASS



Galileo



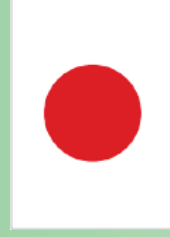
COMPASS



GINSS

Regional 区域性系统

系统



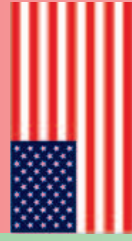
QZSS



IRNSS

Augmentations 辅助改善系统

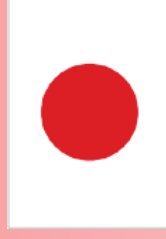
系统



WAAS



EGNOS



MSAS



GAGAN



SDCM



SNAS



CWAAS



CSTB

Adapted from Gunter Hein, International GPS/GNSS Symposium 2009, Korea
引用自2009年韩国国际GPS/GNSS学术讨论会



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Thank you 谢谢

