HIGH SPEED RAIL

The Big Picture

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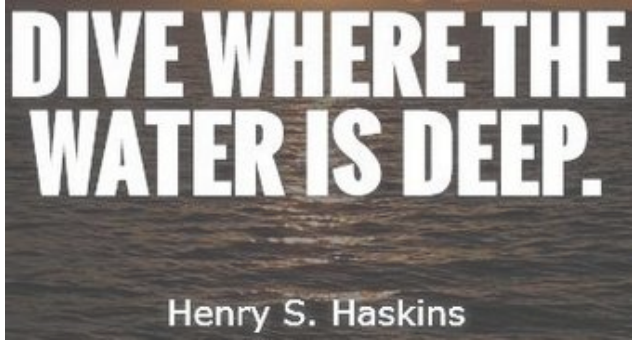
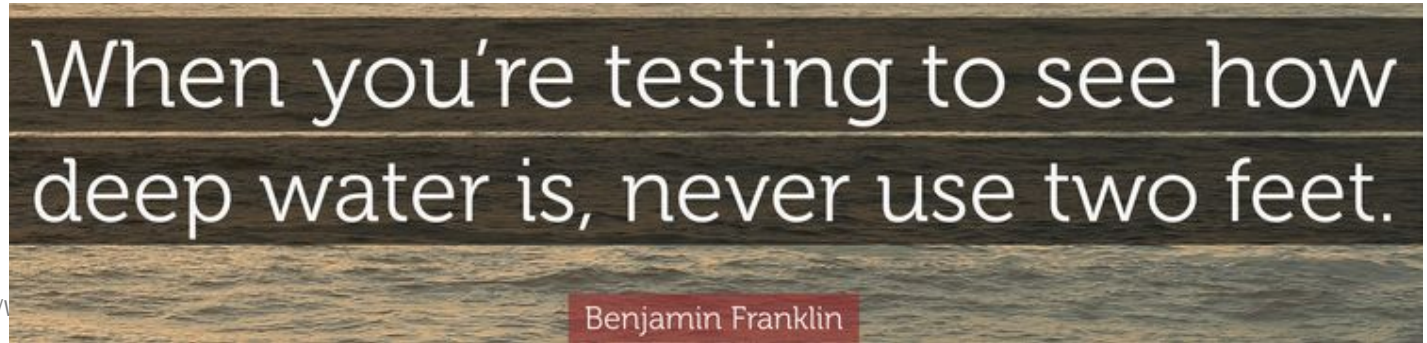
FIRST THINGS FIRST…



- *I am no expert!* Just a lot of reading and some personal experiences
- High Speed Rail (HSR) encompasses decades of scholarship, and no one session by even a panel of experts can sufficiently capture any facet of its complexity
- The aim of this session is to sharpen your curiosity and increase interest in HSR



WHY DO WE TALK SO MUCH ABOUT HSR ?

- The ***development*** of HSR globally has ***followed many different paths***, greatly influenced by prevailing geopolitical/socio-political and economic considerations
- HSR is invariably a ***highly capital intensive enterprise*** that entails a lot of complexities in its planning, design, construction, operation and maintenance works, and with far-reaching socioeconomic implications (***megaproject***)
- HSR is one of the ***fastest growing*** rail transport sectors in the world today, and is set to attract even more attention over the next decade

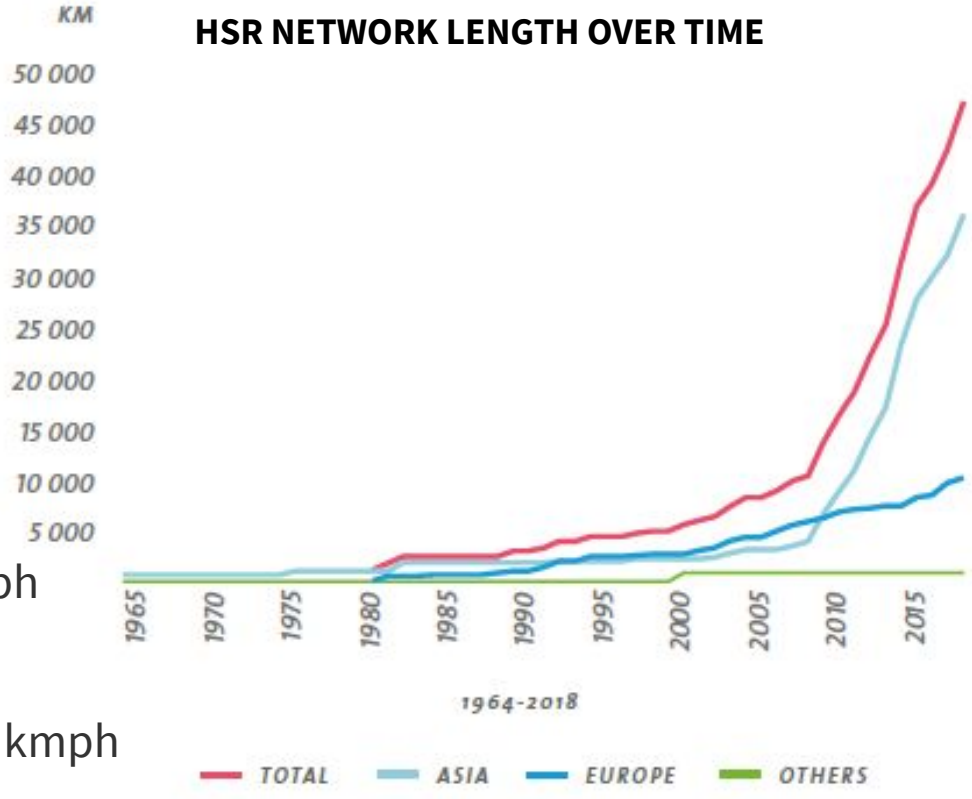
WHAT IS HSR?

- Grounded, guided, low-grip transport system (*UIC 2018*)
- **Speed > 200 kmph** *using*: tracks, rolling stock, signalling, operation control centres (lines may be exclusively dedicated or mixed, but freight generally kept separate)
- ***Combination*** of several infrastructural elements forming a single integrated system
- Railway subsystem consistent with various global HSR standards
- ***Feasibility criteria***: *Interoperability, high capacity, safety & security, sustainability*

HISTORY OF HSR DEVELOPMENT

- **1964** : Tokaido Shinkansen, Japan
  Tokyo – Osaka (515 km) line @ 210 kmph
- **1978** : *Direttissima* Line, Italy
  Rome – Florence (254 km) @ 200 kmph
- **1981** : TGV Service, France
  Paris – Lyon (450 km) @ 260 kmph
- **1991** : InterCity Express (ICE), Germany
  Hannover – Würzburg (327 km) @ 280 kmph
- **2003** : Qinshen railway, China
  Qinhuangdao – Shenyang (404 km) @ 200 kmph

HSR NETWORK LENGTH OVER TIME



UIC, 2018, "High Speed Rail"

BENEFITS OF HIGH SPEED RAIL

- ***Economic*** impact
  - Huge ***capital*** outlay
  - ***Investment*** in the new market
- ***Quality of life***
  - Scalable, safe, convenient
- ***Technological*** competitiveness
- ***Strategic*** importance
  - Territory integration
- ***Environmental*** Sustainability

Adj.: *NS Business Hub, Feb 2020, www.ns-businesshub.com*

DEVELOPMENTAL FEATURES: INFRASTRUCTURE

- ***Land purchase remains a significant difficulty*** for infrastructure development in Asia. Japan has used ***land trust schemes*** through a trust bank, but not yet others
- Pre-feasibility and feasibility studies are important to bolster the design stage
- Most lines take 5-6 years to build after taking possession of land, provided ***tunnels and viaducts*** are not numerous and long
- ***Other considerations*** include:
  - Dedicated or mixed traffic?
  - Ballasted or ballast-less (slab) track?
  - ***Superstructure***: Turnouts, signals, ***electrification***


Girder Laying (Courtesy NHSRCL)

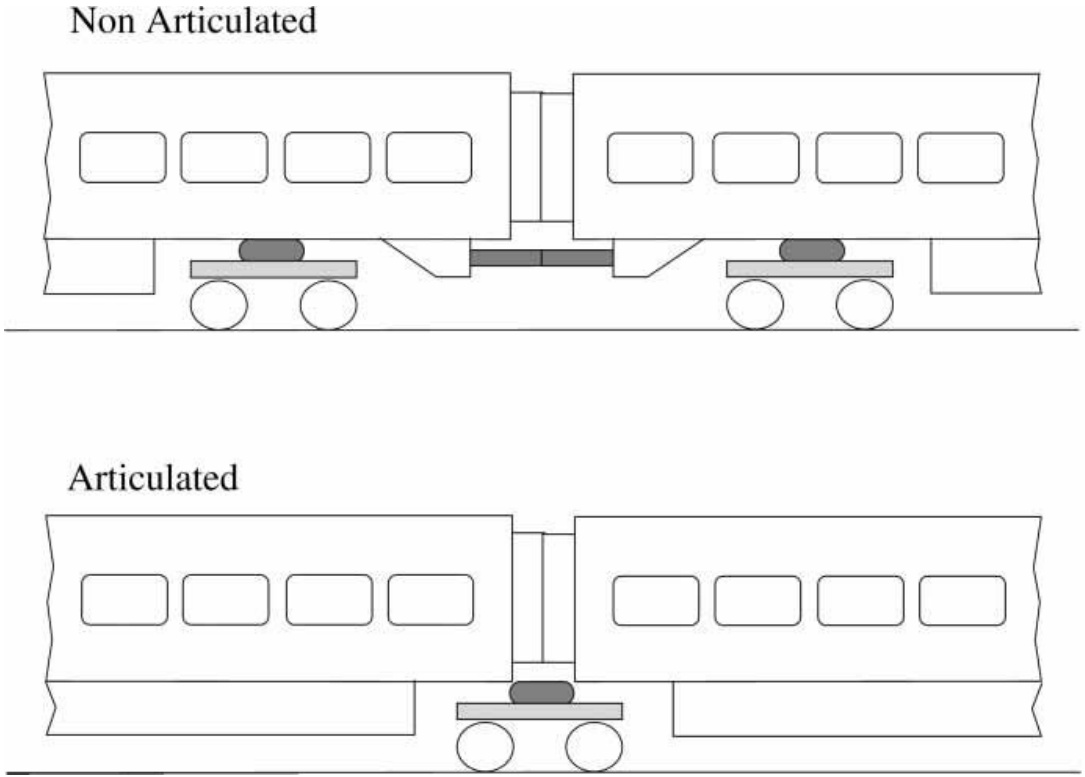
ROLLING STOCK: TECHNICAL CONSIDERATIONS

- ***Interoperability*** of ***gauge*** (NG to BG) and ***electric (traction) system*** (varies from 0.75V DC to 25 kV AC or non-electric). Technical Specifications for Interoperability (***TSI***) are compulsory in Europe for both infrastructure and rolling stock
- ***Maintenance*** – generally organized as a ***4- or 5- level process*** to fit both the commercial usage schedule and the rolling stock life cycle
- ***RAMS*** (***R***eliability, ***A***vailability, ***M***aintenance, ***S***afety)
- ***Control circuits & software*** (including in-cab *signalling, GTO/IGBT, braking system*)

ROLLING STOCK: TECHNICAL CONSIDERATIONS

- ***Articulated*** *vs* ***non-articulated*** – length limited by bogies but higher stability
- ***Aerodynamic Profiles*** – depending upon the navigation terrain/topology, ***EN14067***
- ***Tilting Trains*** (***Pneumatic*** *vs* ***Hydraulic Tilt***) – to navigate curves at speed
- ***Pressure Comfort*** criteria ***(Air Leakage)*** – Pressurised cabins during run
- ***Ride Index (***Vibrations; ***Ride Comfort)*** – keep as low as possible
- ***Noise or Boom*** (e.g. when passing through tunnels) – rms weighted avg & peak ***min***
- ***Technical Compatibility Standard: UIC 660***

ARTICULATED VS NON-ARTICULATED TRAINS



Qualitative comparison of the characteristics of articulated and non-articulated trains and their effects on impact, Xue et al, Proc. IMechE Vol. 225 Part F: J. Rail and Rapid Transit, Jan 2011, Pg 24-37

HSR ROLLING STOCK FLEET

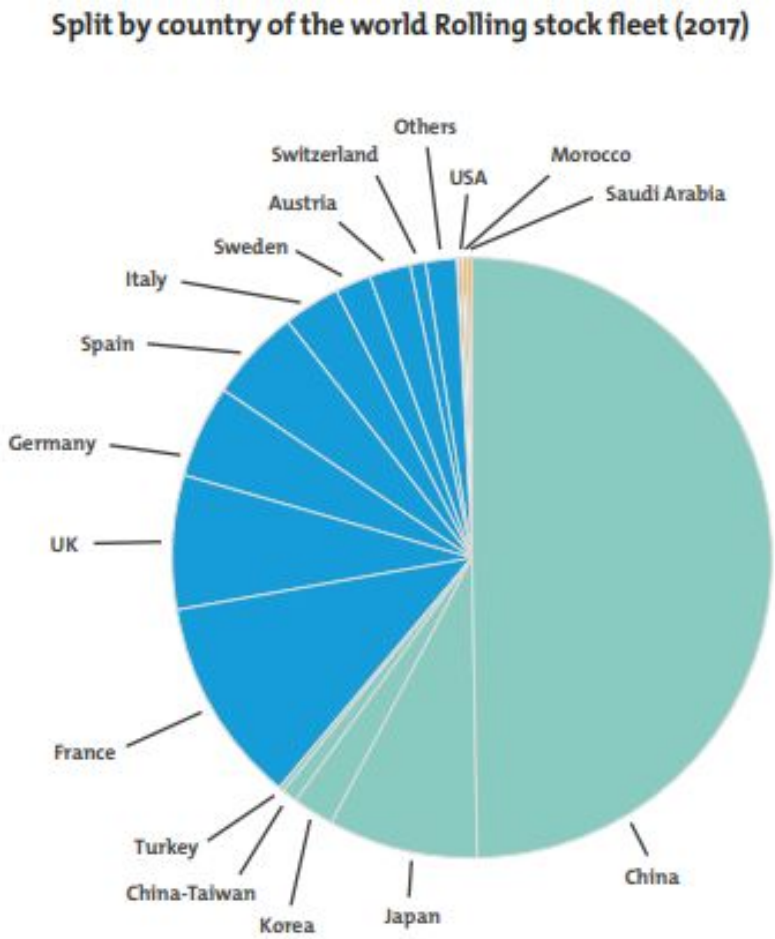
Major players in the West (Europe & Canada)

BOMBARDIER ALSTOM

SIEMENS Talgo

Major player in Asia (China)

中国中车 CRRC



UIC, 2018, "High Speed Rail"

MAJOR SHINKANSEN SUPPLIERS' MARKET SHARE

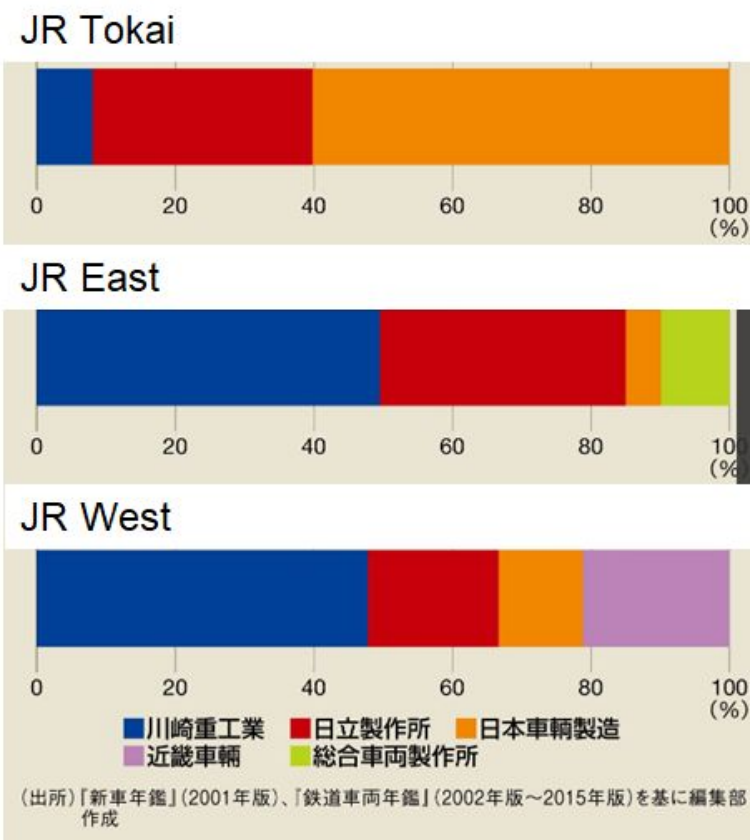
HITACHI

Kawasaki

日本車両

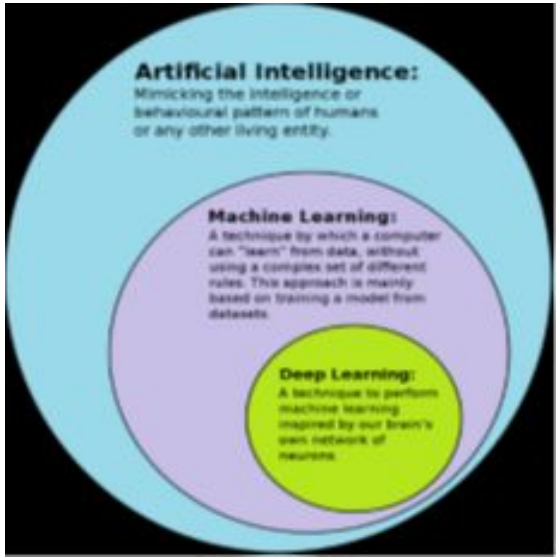
KINKI SHARYO

J-TREC



EMERGING TECHNOLOGIES: AI & ML

- Image recognition
- Chatbots & Virtual Assistants
- Sales Prediction through ML
- Station Staff & Cleaning Crew
- Warehouses
- **Predictive Maintenance** of ***Rolling Stock*** & ***Infra***
- **Automatic Train Operation (ATO)**



"Artificial Intelligence Case of the Railway Sector", UIC Rail System Dept, UIC, March 2021,

EUROPEAN YR of RAIL ‘21

- Online ticket booking for international rail travel
- European Strategy on AI and Data 2020
- Double passenger and freight traffic by 2030
- Shift2Rail
- Mobility as a Service (MaaS)
- Automatic Translation Service at borders

JAPAN

- Integrated Suica/PASMO system
- AI-based guidance at stations
- Smart maintenance
- AI-based non-contact displays
- “Move Up” 2027 (JR East)
- Smart Trains
- Expanding the role of Suica