ICEC 2014 - IX World Congress
Re-Engineering Total Cost Management
Milan (Italy) - 20, 21 and 22 October 2014

The management challenges of building a **World Cup stadium** in the **Amazon**

Aldo MATTOS
Carlos Henrique LIMA
Gláucia ALVES
José Antônio FERNANDES

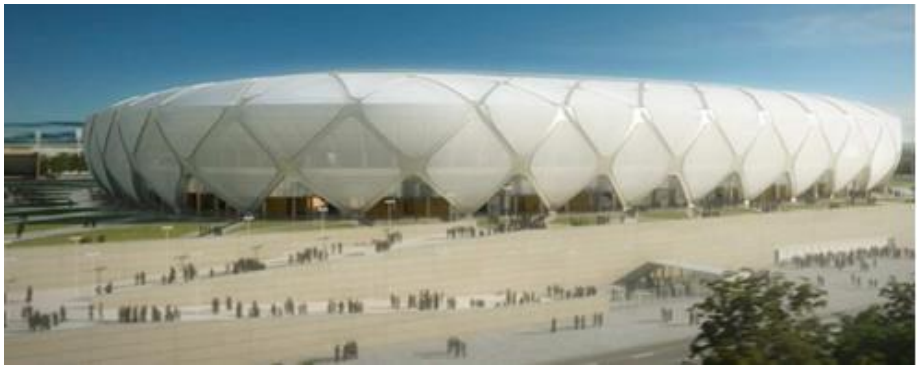
Authors

ALDO MATTOS
CONSULTING

FIFA 2014 World Cup

Source: Fifa

Amazon Arena



Owner	• State of Amazonas
General contractor	• Andrade Gutierrez
Architect	• GMP Architekten (Germany)
Contract value	• 500M BRL (= 280M USD)
Duration	• 36 months

Manaus

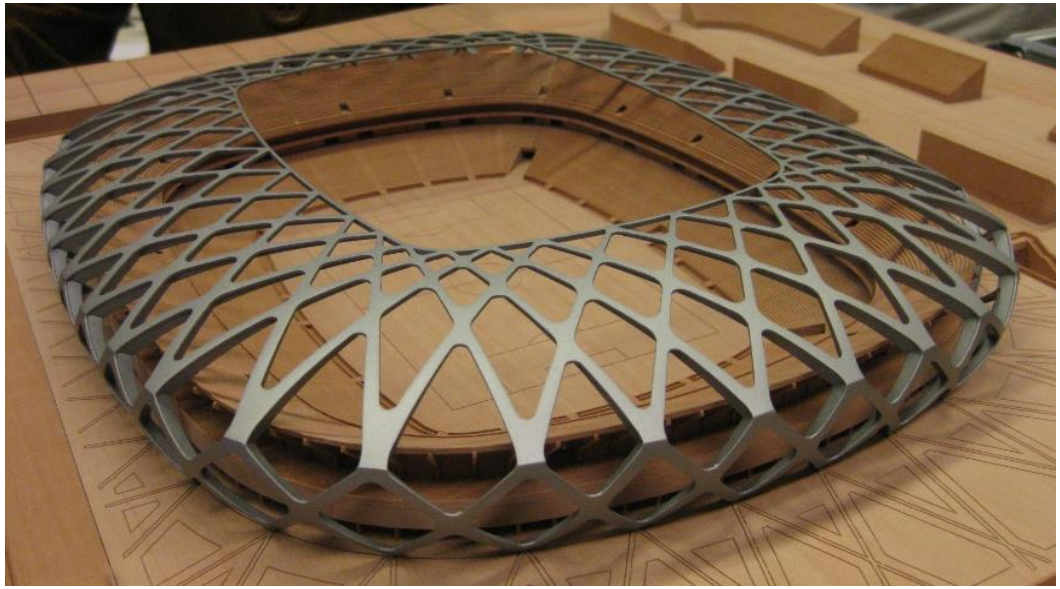





Manaus Turismo

- In Amazon Rainforest
- Distance to São Paulo = 3,000 km (1,800 mi)
- Accessible only by **boat** or **airplane**
- Temperature: 20º–37º C

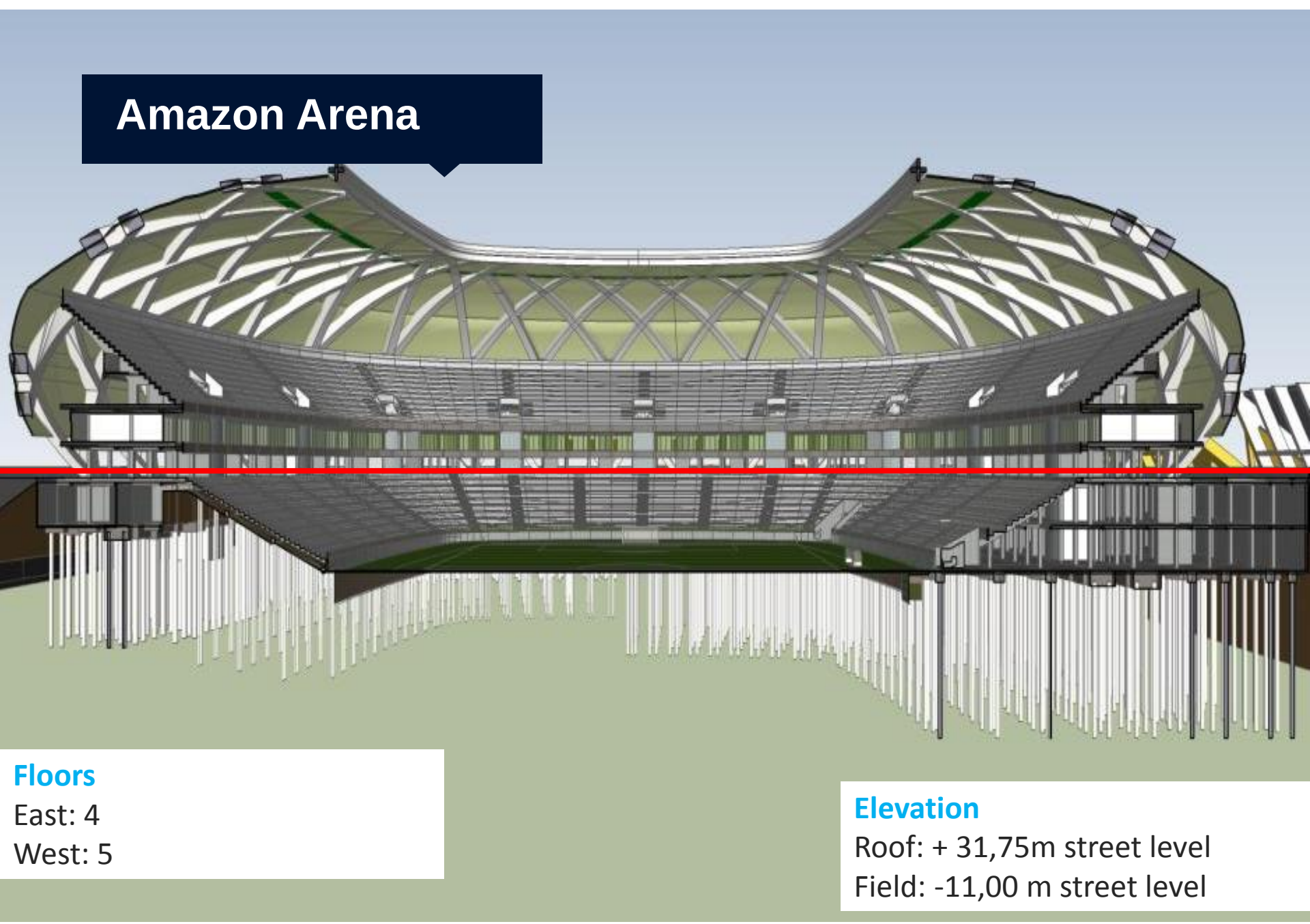
Amazon Arena




Area = 83,500 m²


© Alcides Netto | Andrade Gutierrez
Capacity = **43,300** seats

Amazon Arena



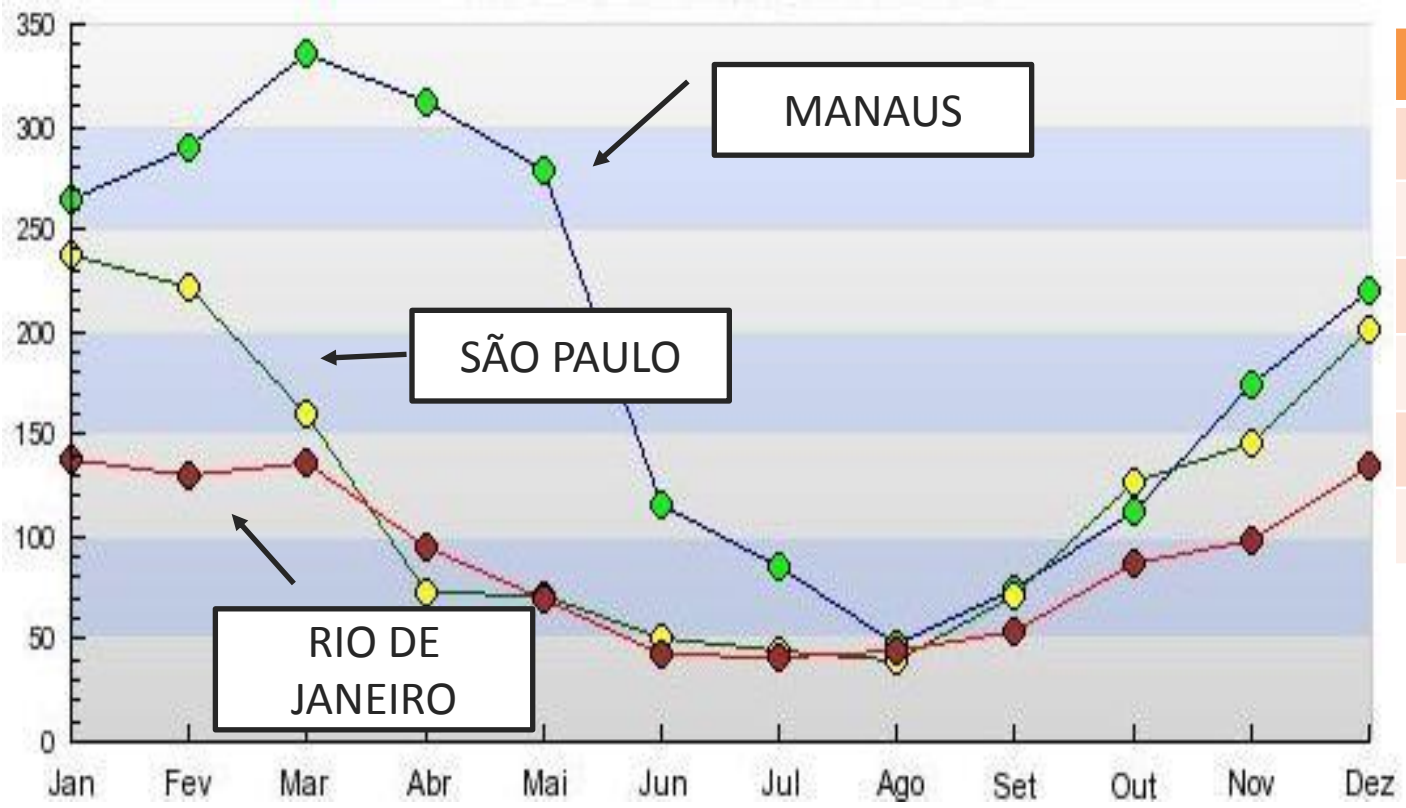
Floors
East: 4
West: 5

Elevation
Roof: + 31,75m street level
Field: -11,00 m street level

Amazon Arena


Challenge no. 1
Climate

Manaus – rainfall (mm)



City	mm/year
Manaus	**2300**
NY	1270
Milan	1000
Amsterdam	900
Paris	650
London	600

Climatempo

Rainfall: 2300 mm/year
Intense and short rainfall = loss of productivity

Design

- **Preliminary** design (2009) – FIFA **2007** specifications
- **Final** design (2011) – developed by the Contractor – FIFA **2010** specifications

www.d24am.com

www. http://arquiteturaplus.blogspot.com.br

Challenge no. 2

Scope changes

Scope changes

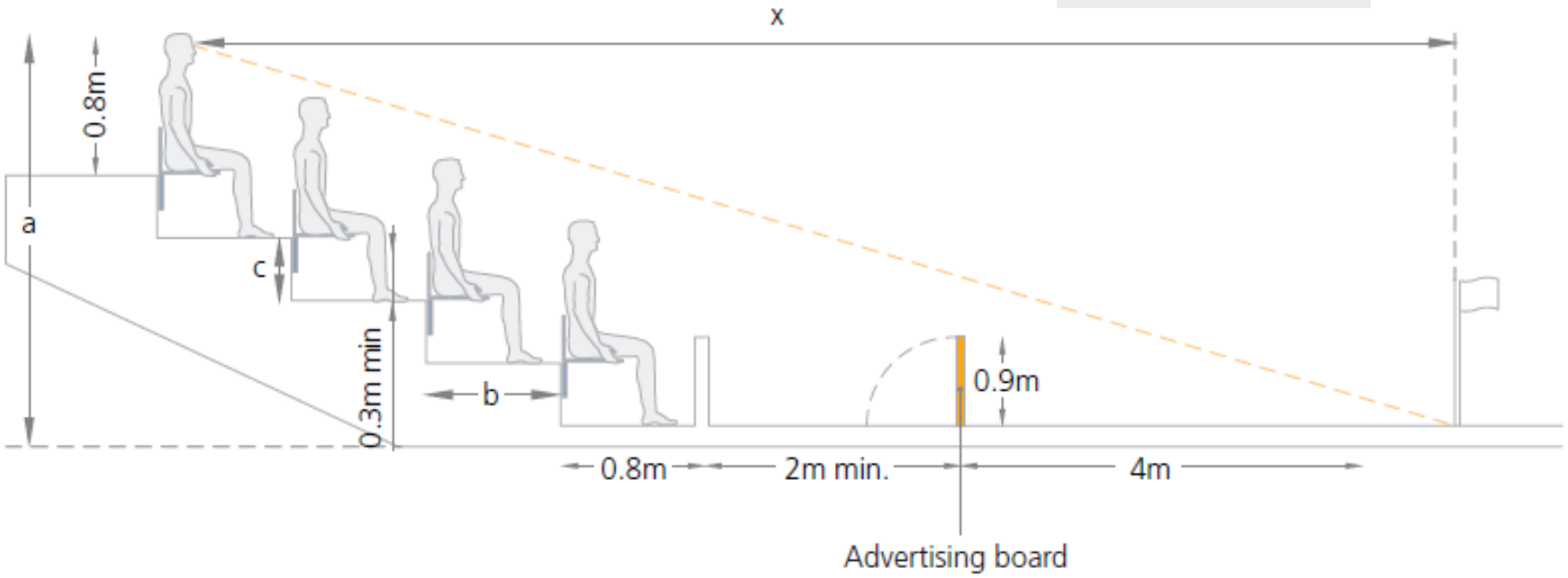
Host cities agreement:

"(…) reserving to the Organizing Committee and FIFA the right to ***MODIFY, DELETE*** *or* ***ADD*** *new requirements* ***AT ANY TIME*** *until the date of the competition"*

Scope changes – line of visibility

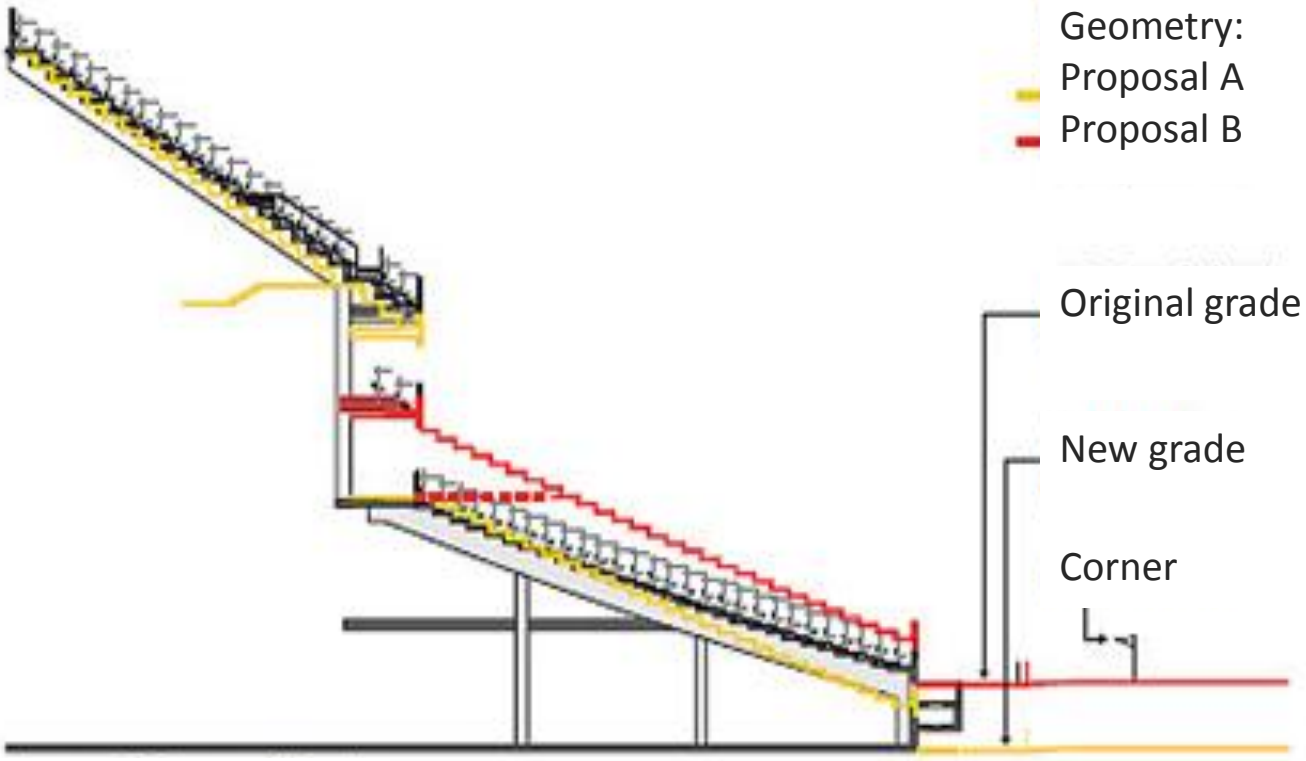
$$x = \frac{a\,b}{c - 12}$$

x = distance visitor – pitch margin



Fifa Football Stadiums Technical Recommendations and Requirements

Scope changes – line of visibility

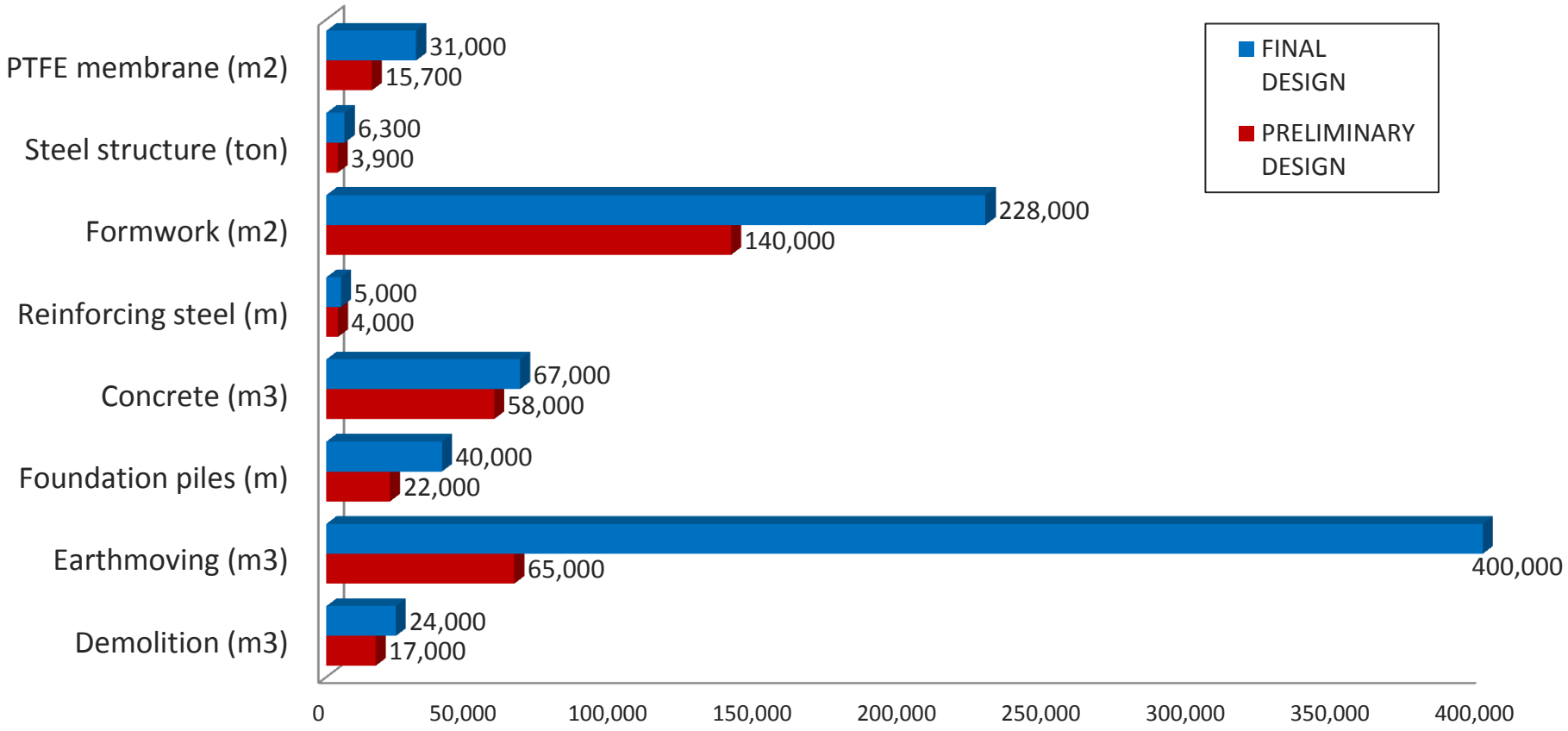


Modified geometry

Andrade Gutierrez

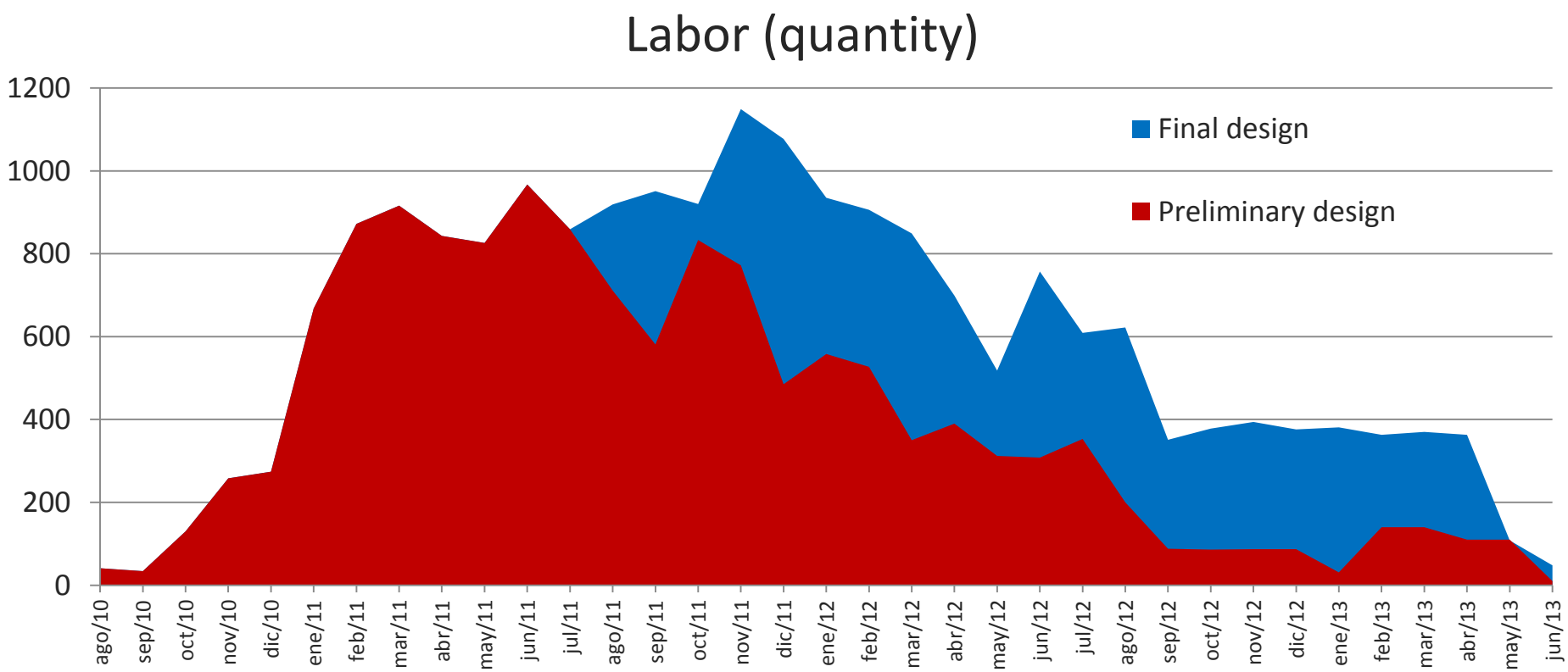
Lowering the lower stands and the field level for better visibility of public

Quantities: preliminary x final design

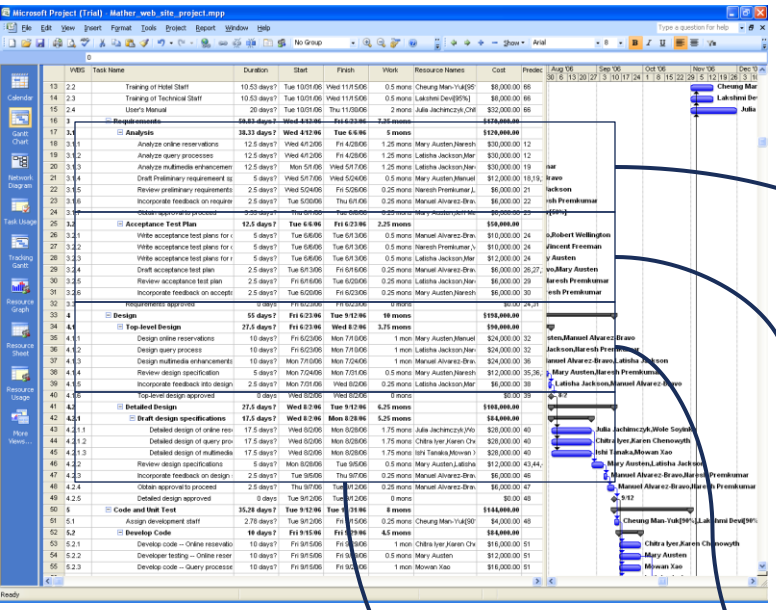


Manpower

More work; same time



4D Planning (BIM)



MS PROJECT

SKETCH UP / REVIT

VÍDEO

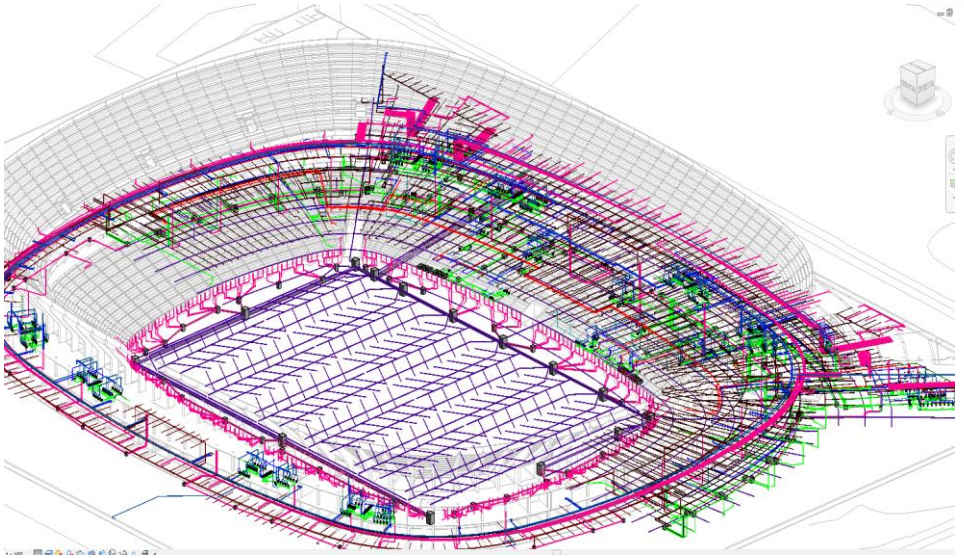
PLANEJAMENTO 4D

4D Planning (BIM)

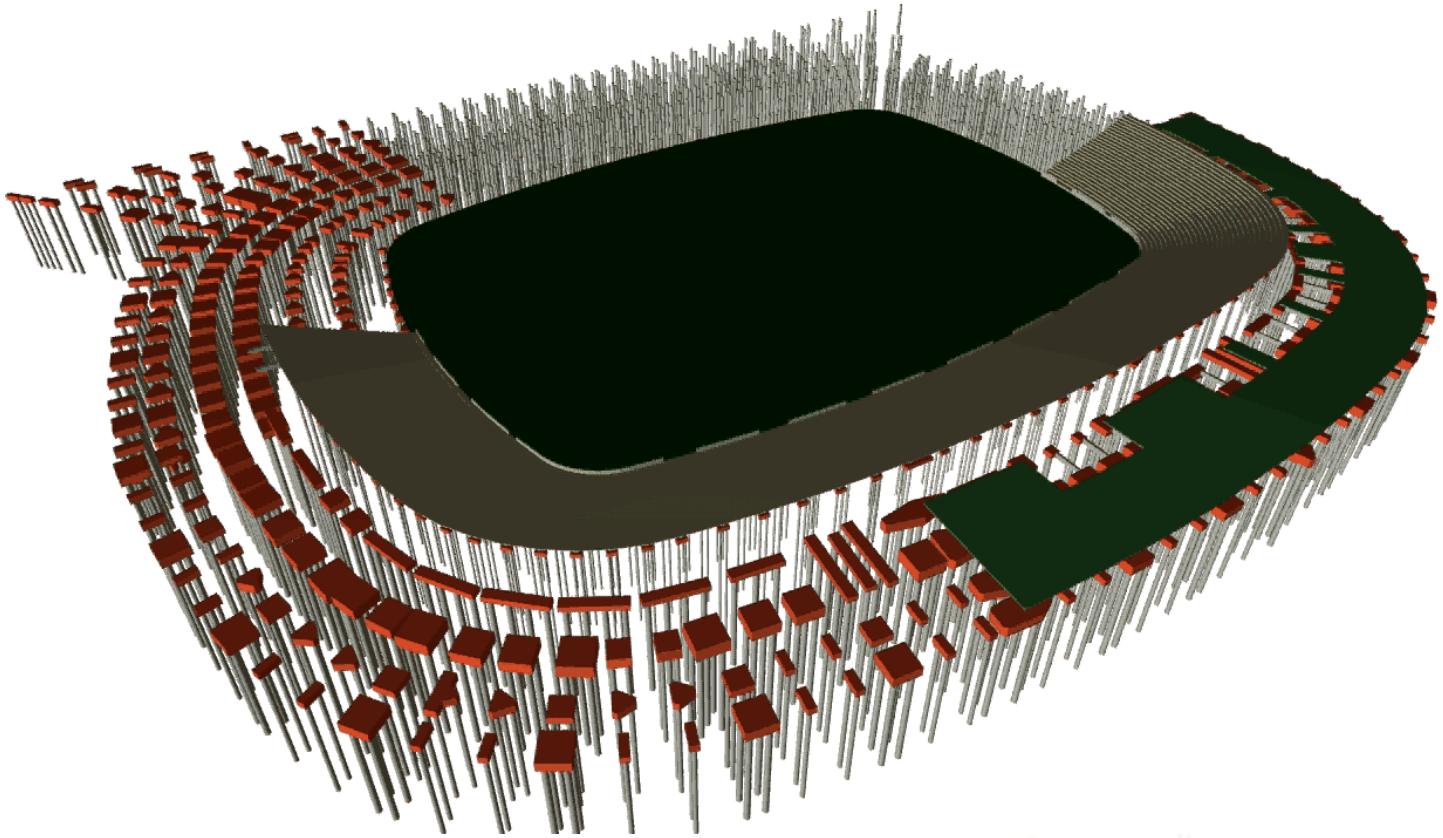
- Better definition of logistics
- Early identification of interference
- Verification of accessibility spaces
- Simulation scenarios
- Instruction of field teams

4D Building Information Modelling (BIM)

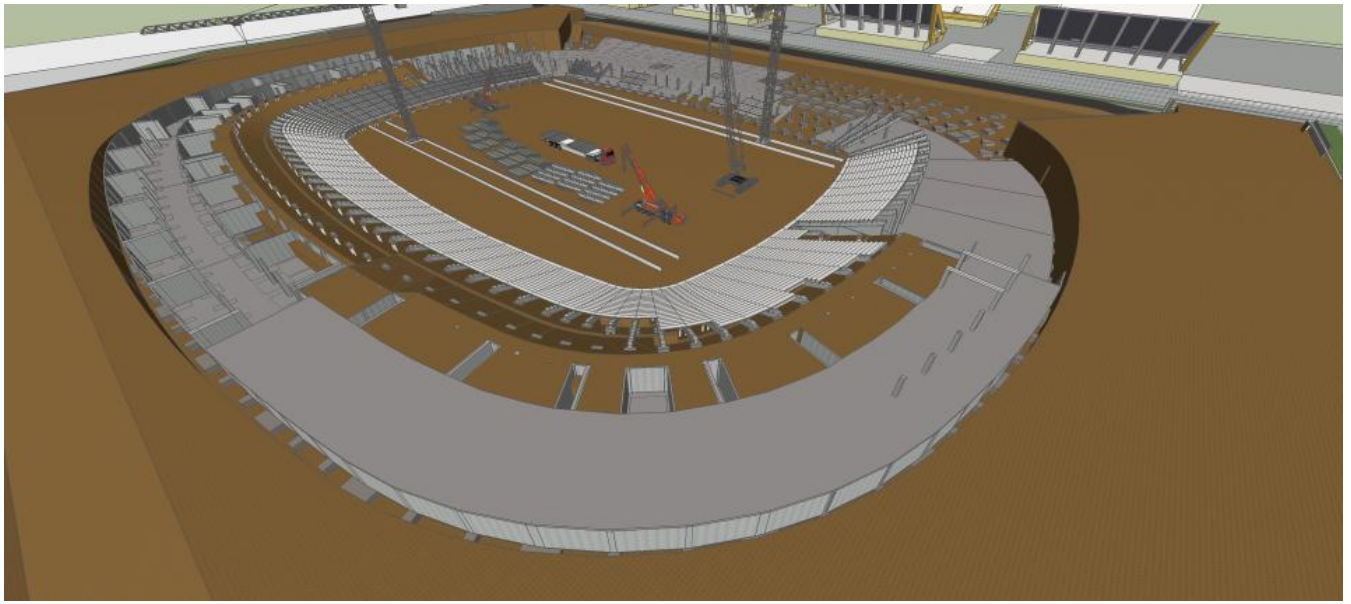
- 4D = 3D + schedule
- Software
  - ArchCad
  - Google Sketchup
  - MS Project

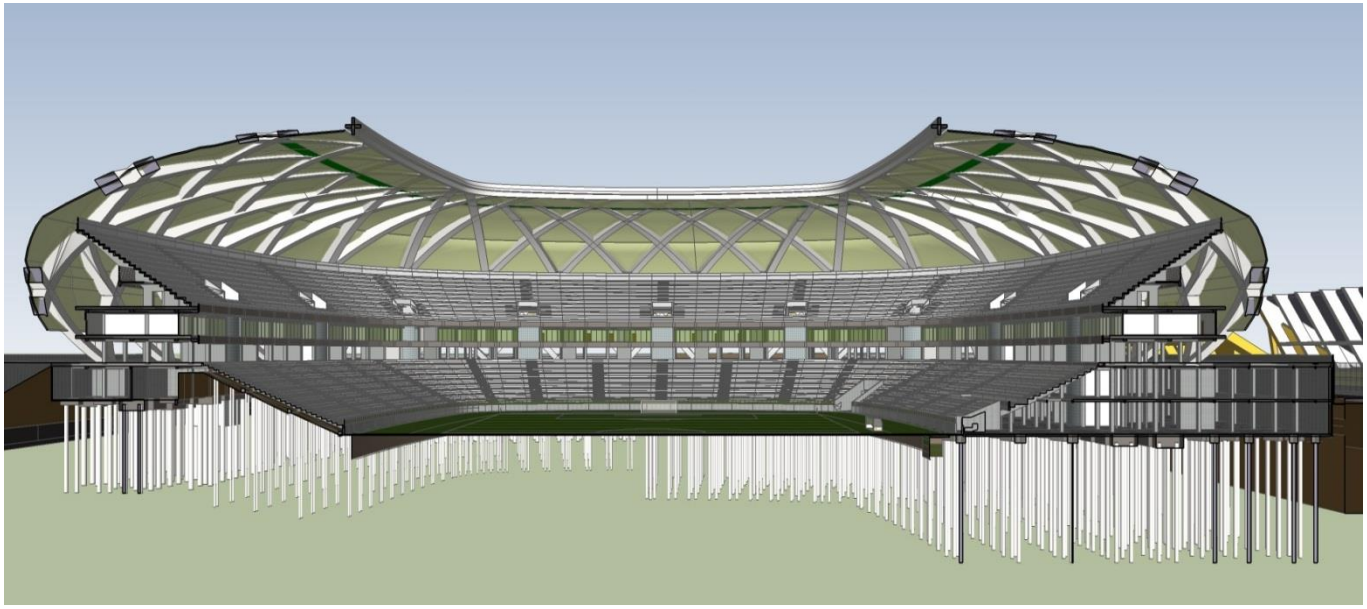


Construction Scheduling – Line of Balance



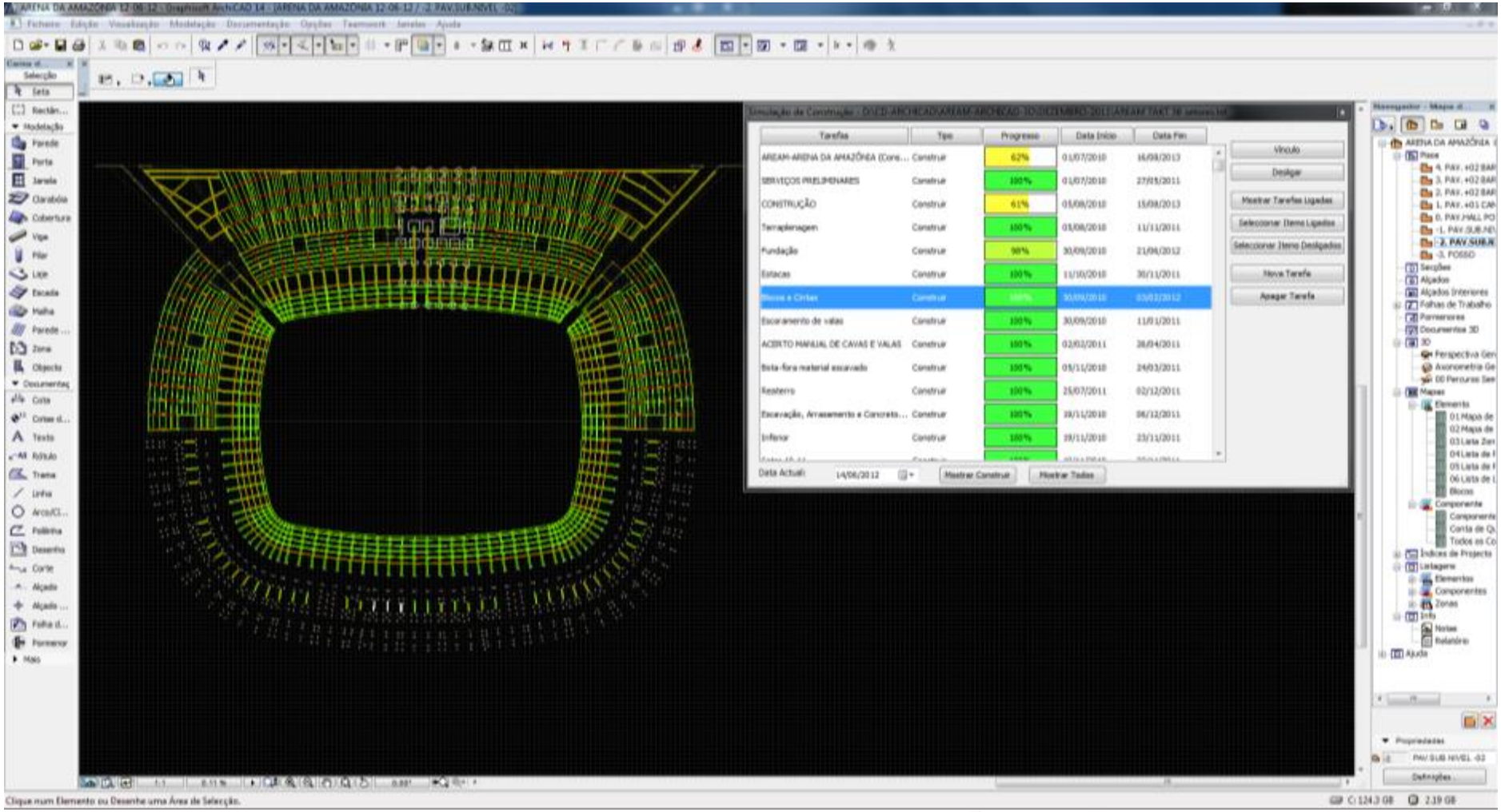
4D BIM



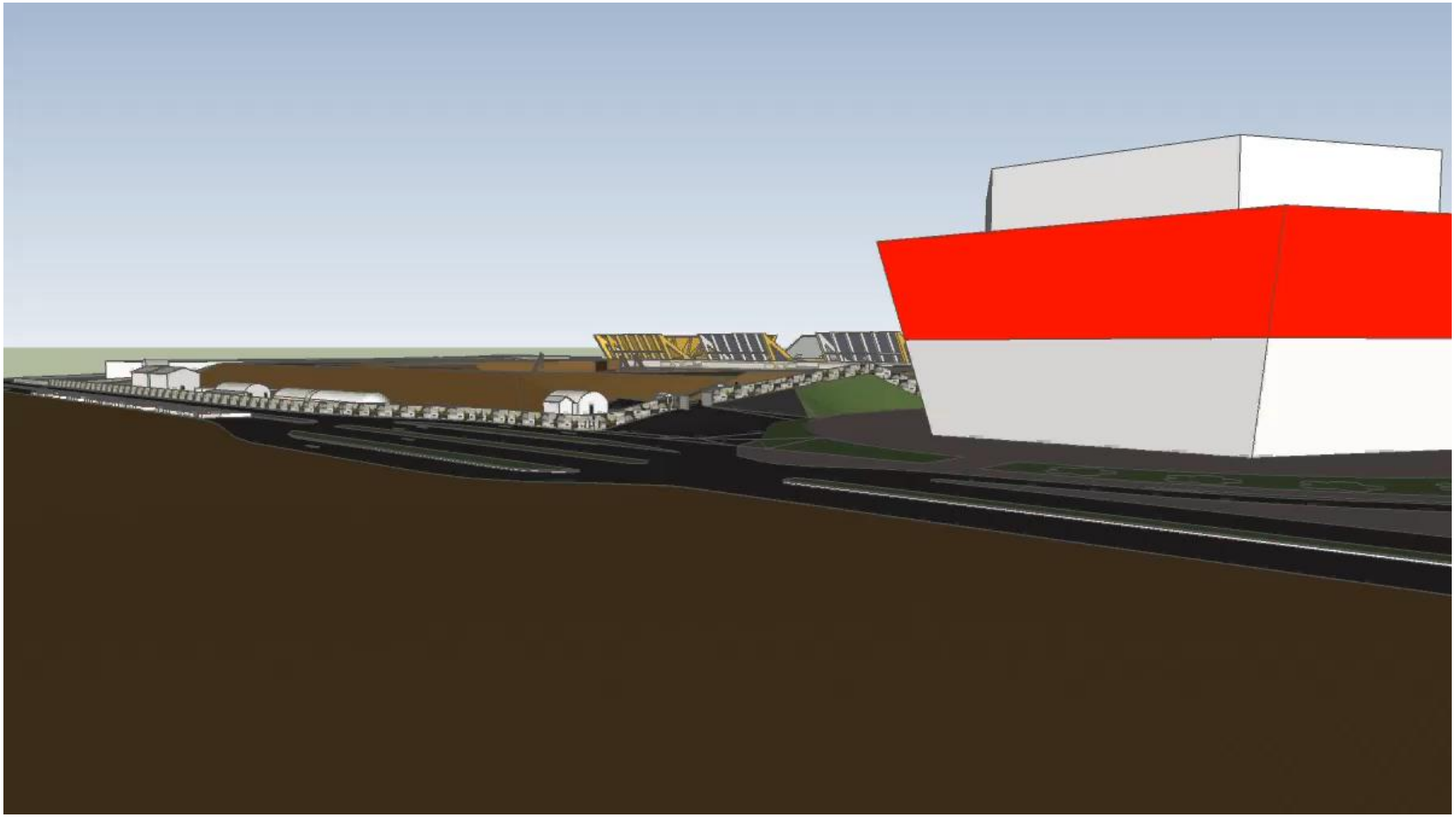


4D BIM

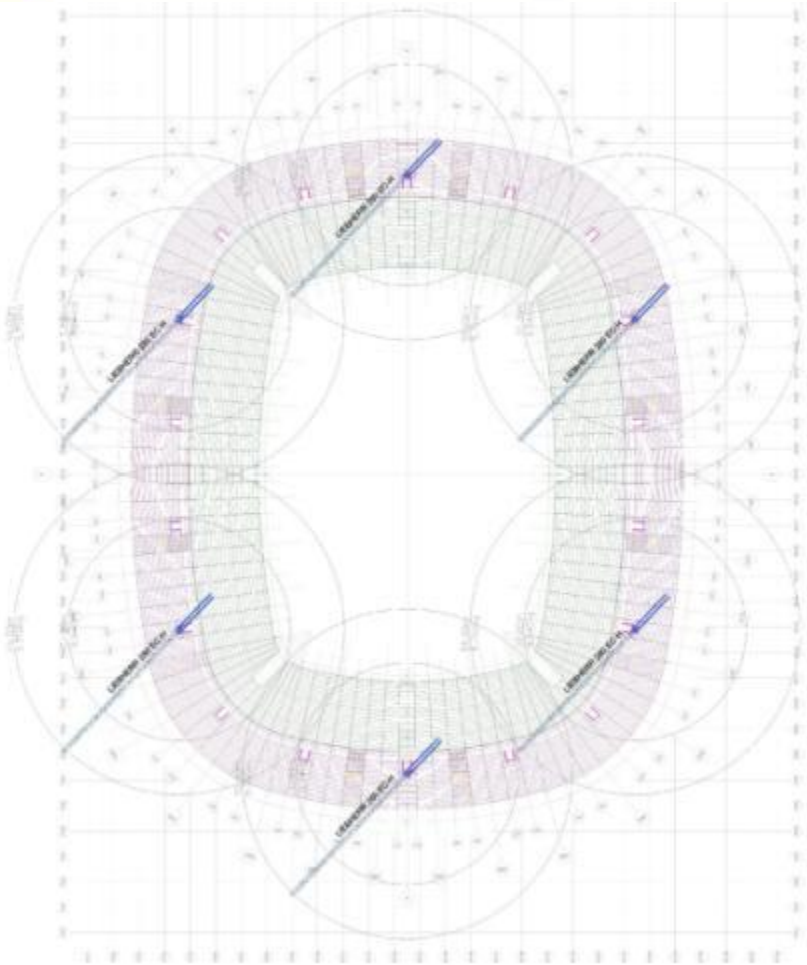
4D BIM


Tarefa
Tipo
Progresso
Data Início
Data Fim
Vínculo
Desligar
Mostrar Tarefas Ligadas
Seleccionar Items Ligados
Seleccionar Items Desligados
Nova Tarefa
Apagar Tarefa
Data Actual:
Mostrar Construir
Mostrar Todos

4D BIM

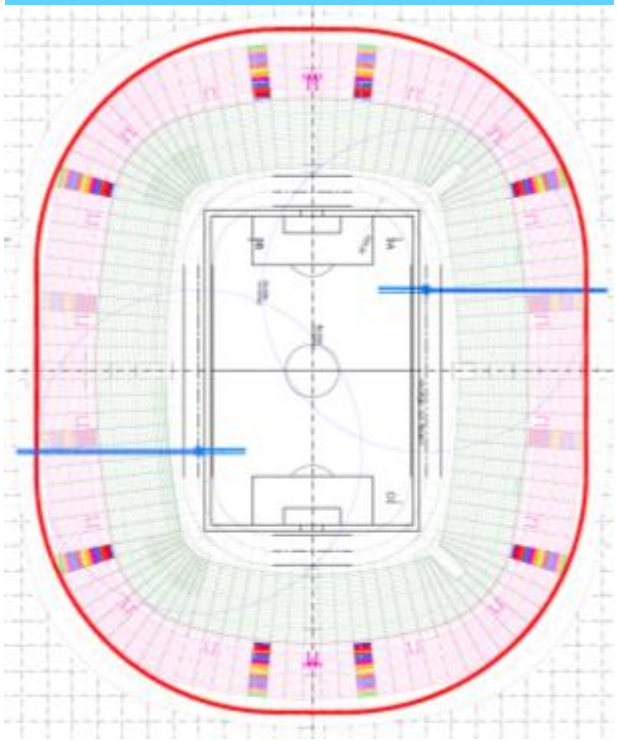


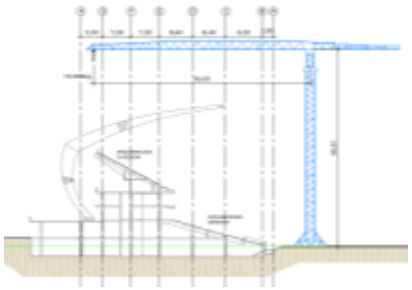
Value engineering – cranes

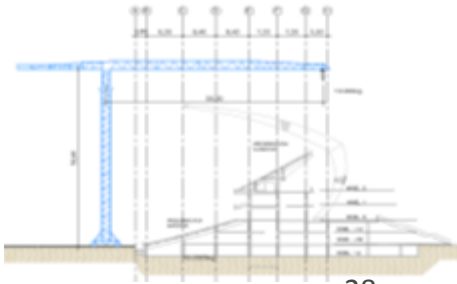


6 fixed cranes

2 rail-mounted cranes



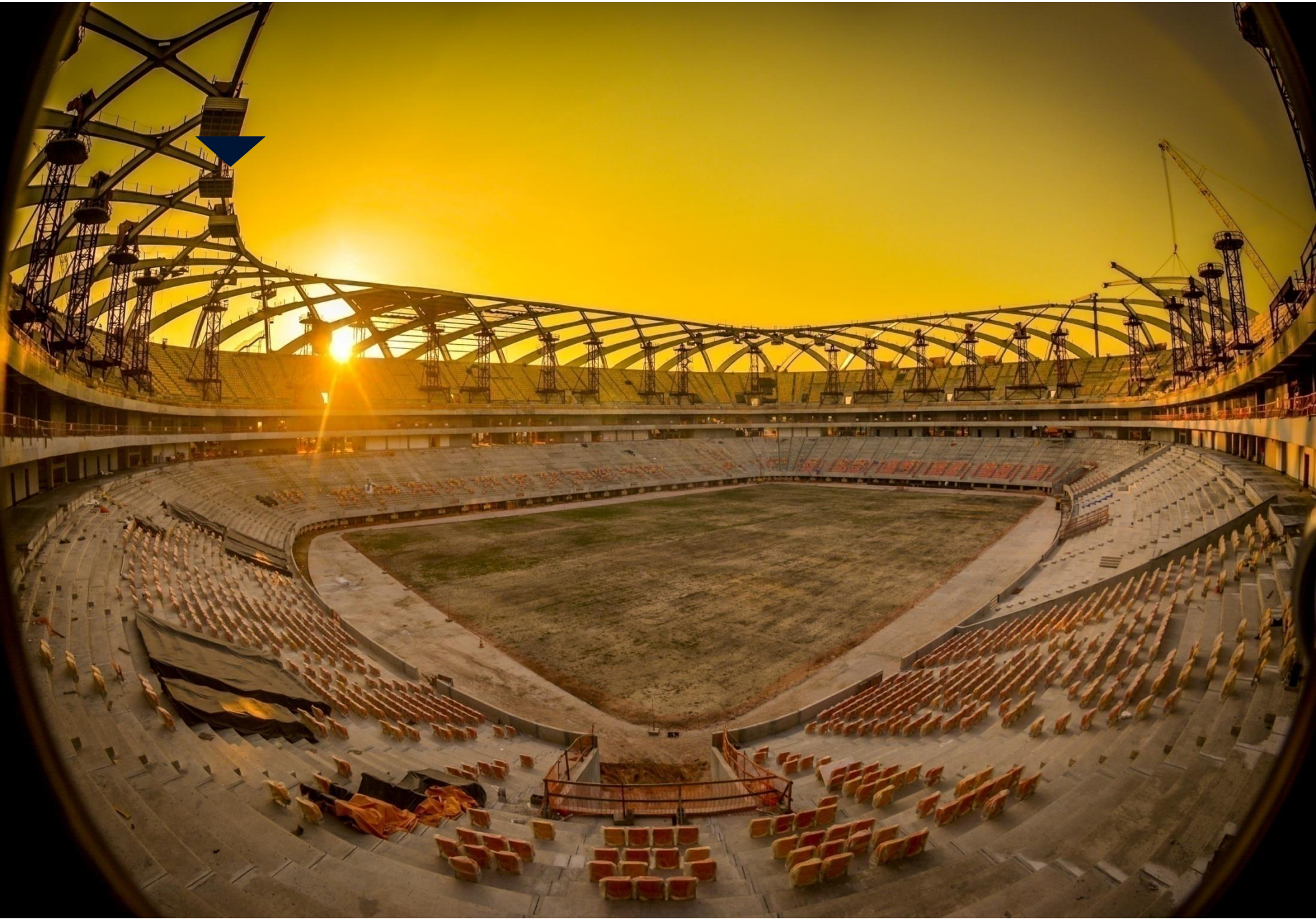




Value engineering – cranes


CAT
320CL
CAT


Reinforced Concrete Structures
Precast steps: 2484 units
Inclined precast beams: 216 units



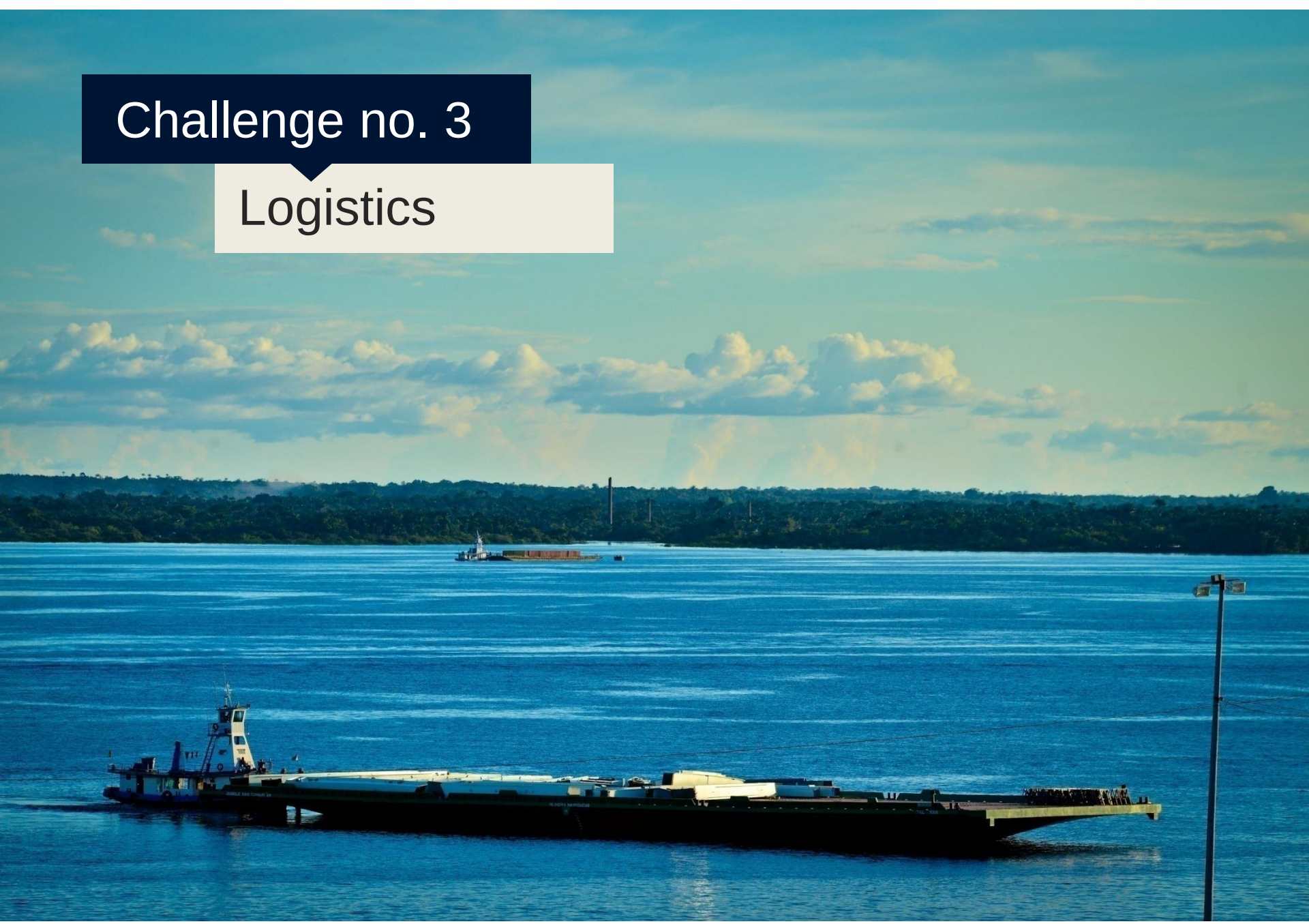

JLG LIFT
AURABRASIL 0800 819 9999
800AJ

Equipment and Vehicles

Total quantity: 175

Challenge no. 3

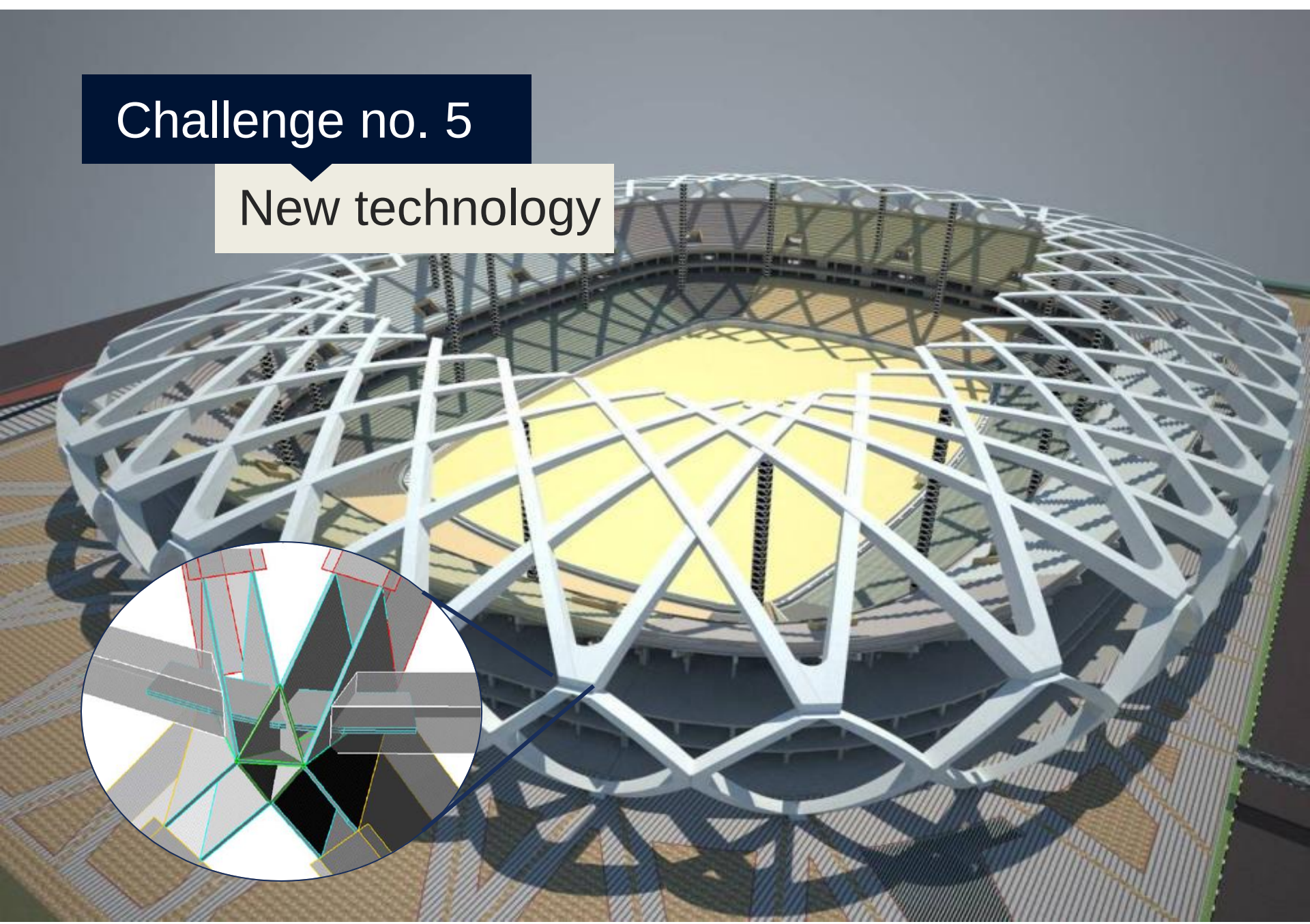
Logistics




Challenge no. 4
Labor skills

Challenge no. 5

New technology



Lean construction

- Lean thinking
- Production management-based approach
- Work is structured throughout the process
- Activities that **add value** x **waste**
- **Necessary** waste x **unnecessary** waste

Waste

Waiting	Moving	Unnecessary processes
Unused area	Transportation	Inventory
Overproduction	Defects	Delays

Areas of improvement

Reinforcing steel production

Precast concrete fabrication

Cast-in-place concrete

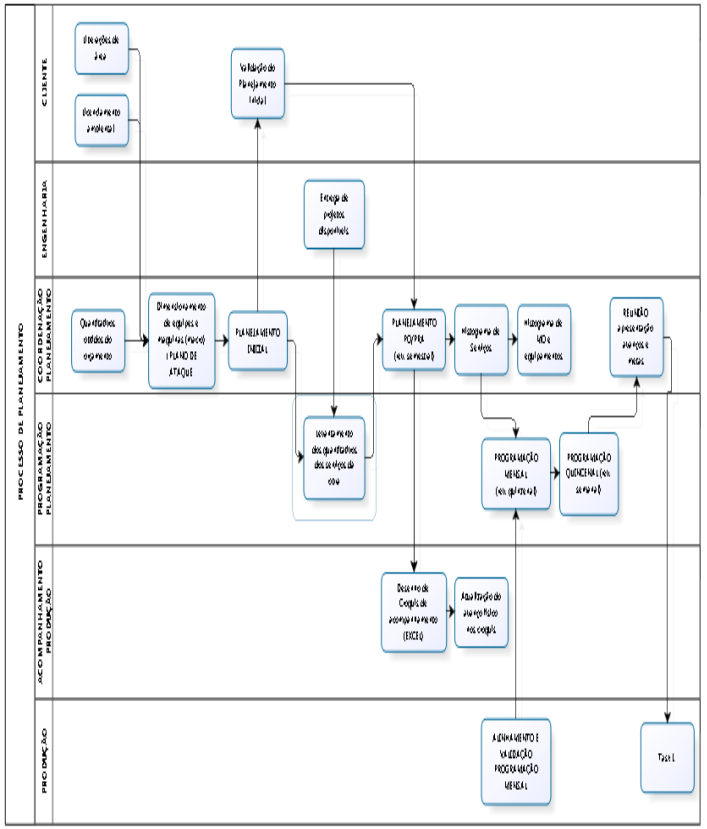
Laboratory

Lean construction – steps

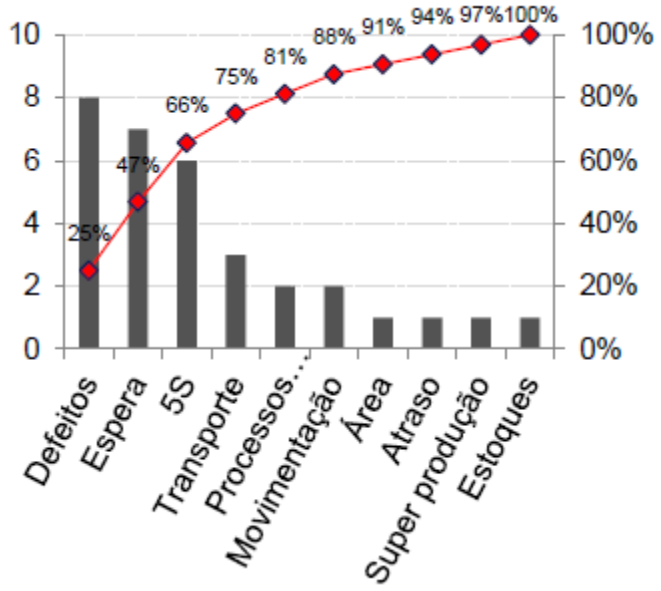
1. Flowchart
2. Qualitative assessment of waste
3. Measurement of displacements
4. Tape-recording and analysis
5. Layout optimization
6. Preparation of operational procedures
7. Mounting of control boards
8. Waste management
9. Visual signs

Flowchart

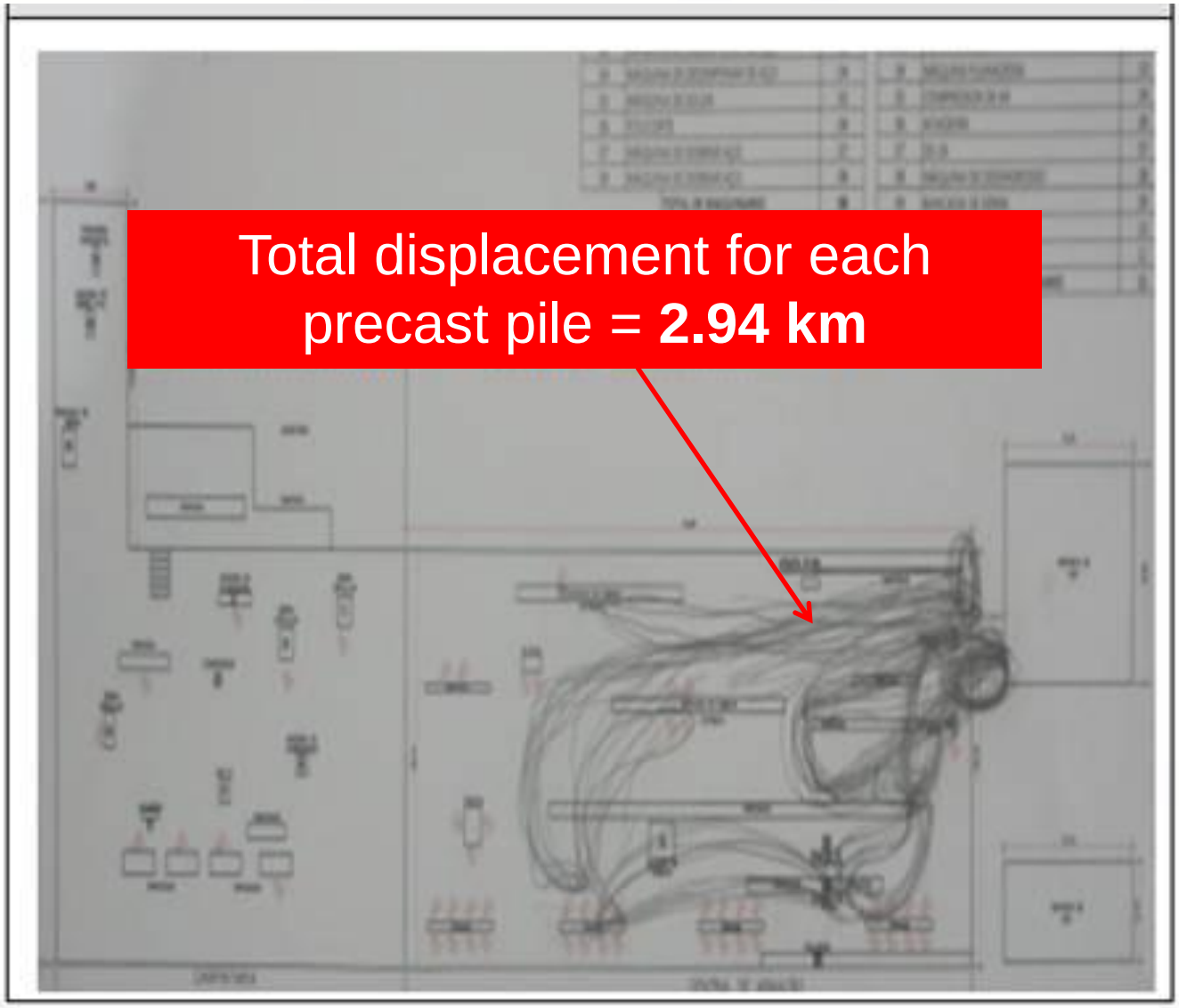

ESTACAS
CORTE
SOLDA
DOBRA MANUAL
DOBRA MECANIZADA
ESTOQUE
MONTAGEM
VIGA
CORTE
Blocos
Diversos


CLIENTE
ENGENHARIA
COORDENAÇÃO PLANEJAMENTO
PROGRAMAÇÃO PLANEJAMENTO
ACOMPANHAMENTO PROMOÇÃO
PROMOÇÃO
PROCESSO DE PLANEJAMENTO
PLANEJAMENTO INICIAL
PLANEJAMENTO POPPS
PROGRAMAÇÃO MENSAL
PROGRAMAÇÃO QUINZENAL
REUNIÃO

Waste assessment

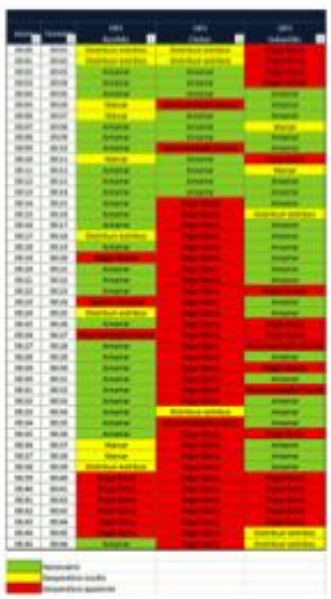


Measurement of displacements



Recording and Analysis

Chronoanalysis



Processo analisado (Armação Degrau)

Tempo realização: 46 min
Com 3 Operadores: 138 min

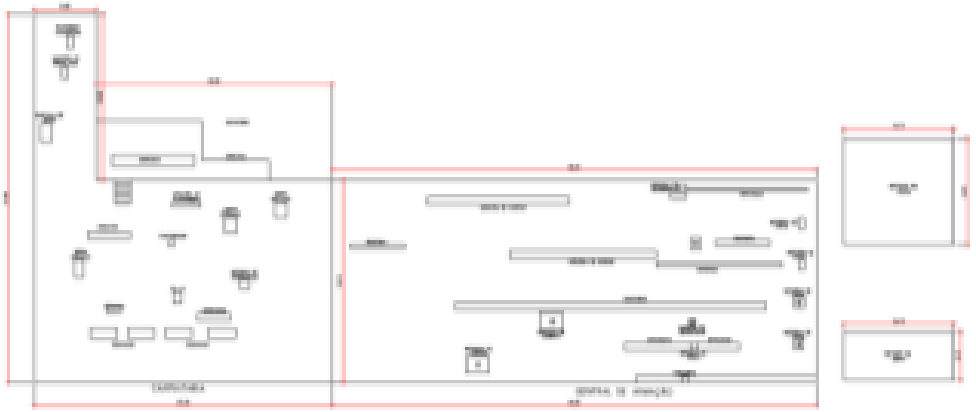
44% agregando valor
13% desperdício oculto
43% Desperdício evidente

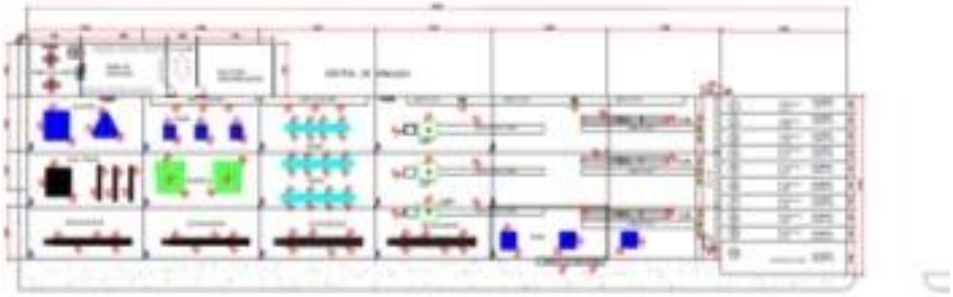
Análise do Método de trabalho (em sala)

Tempo otimizado: 27 min
Com 3 Operadores: 79 min

73% agregando valor
27% desperdício oculto
0% desperdício evidente

Layout optimization



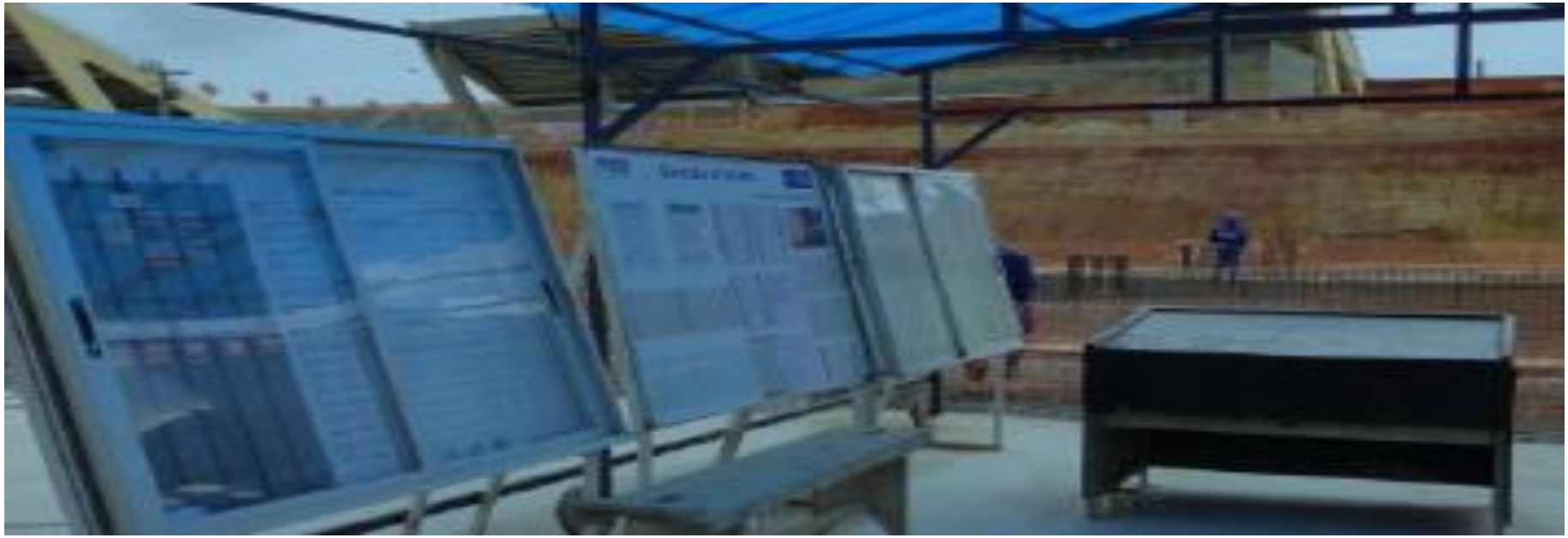


LAYOUT CENTRAL DE ARMAÇÃO

Operational procedure

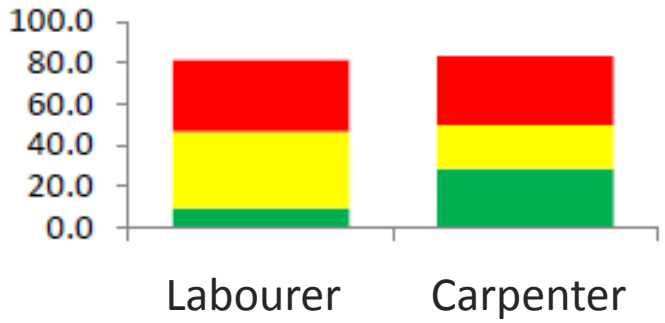
PROCEDIMENTO OPERACIONAL VISUAL							
Elementos:	Forma da Laje in Loco						
Etapa	Processo		Atividade Carpinteiro	Imagem Ilustrativa Atividade Principal	Atividade Ajudante	Imagem Ilustrativa Atividade Secundária	Tempo Atual (Segundos)
	Inicio	Fim					
1	0:00:00	0:01:30	Verificar ferramentas e colocar guia		Separar e trazer todas as formas necessárias para execução da face da laje		0:01:30
2	0:01:30	0:13:30	Encaixar Formas segundo tamanhos existentes		N.A.		0:12:00
3	0:13:30	0:25:30	Martelar as formas já ajustadas		N.A.		0:12:00
4	0:25:30	0:26:20	N.A.		Recolher formas que restaram e devolver ao carrinho		0:00:50
TEMPO ATUAL TOTAL (S)							0:26:20

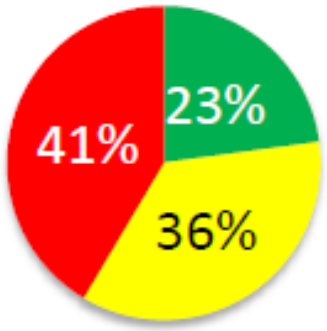
Control boards



Waste management

Before



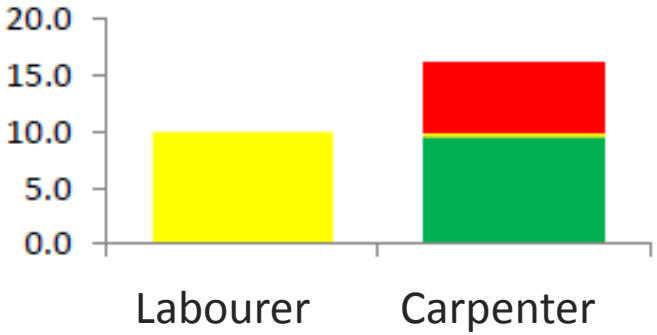


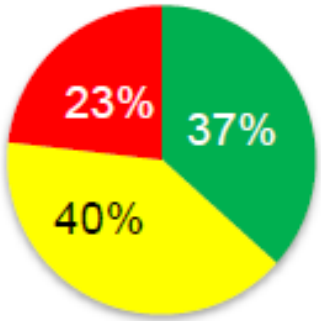
Adds value

Necessary waste

Unnecessary waste

After





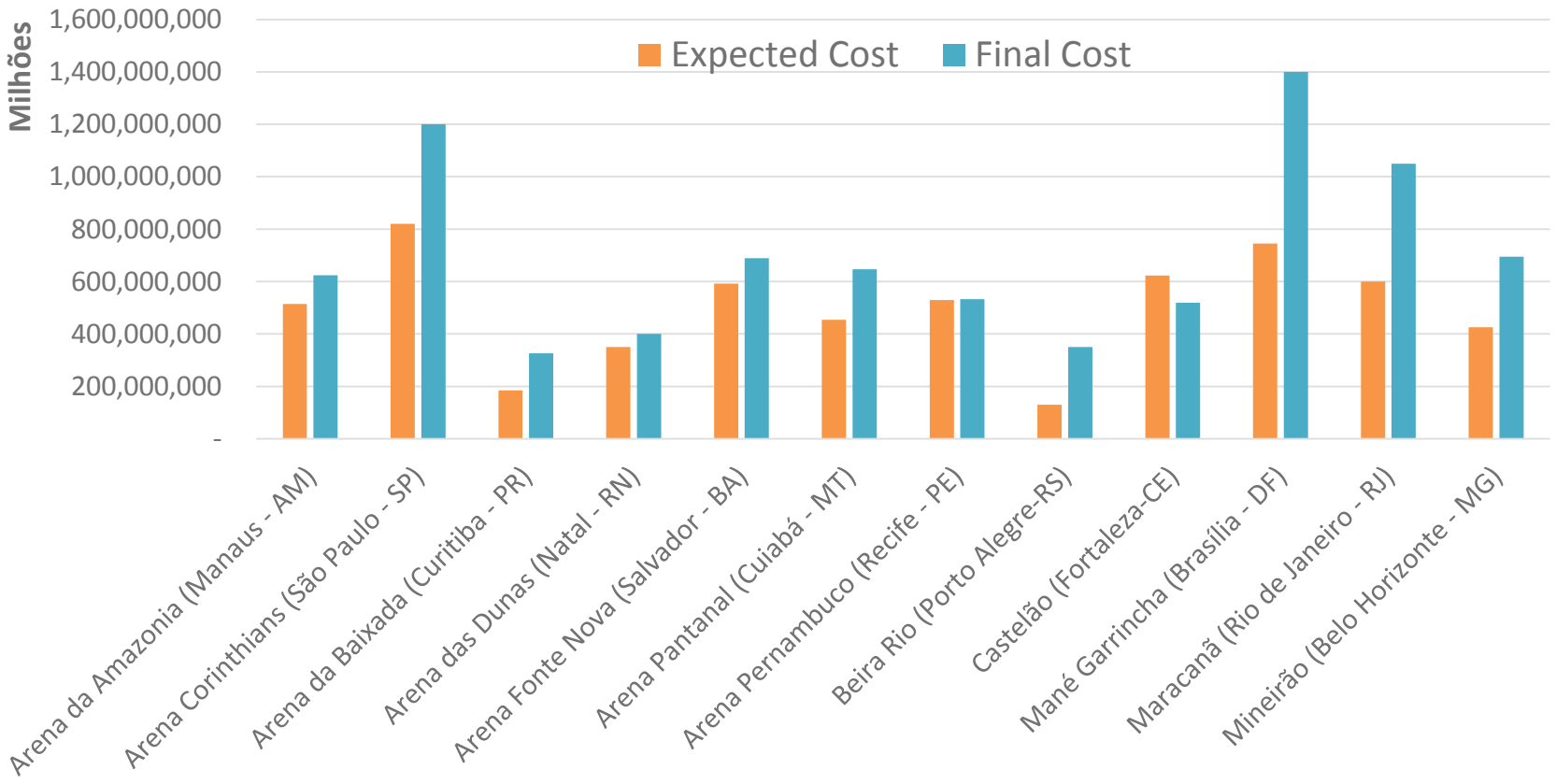
Conclusions

Amazon Arena

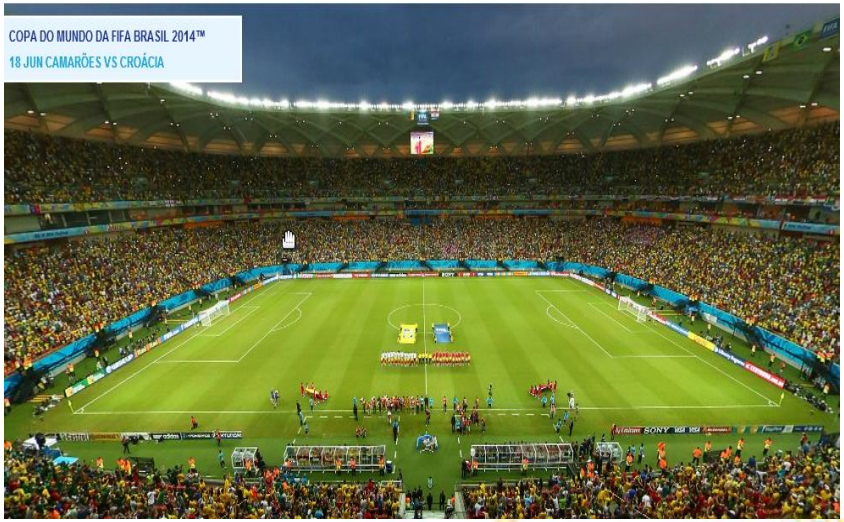
Conclusions

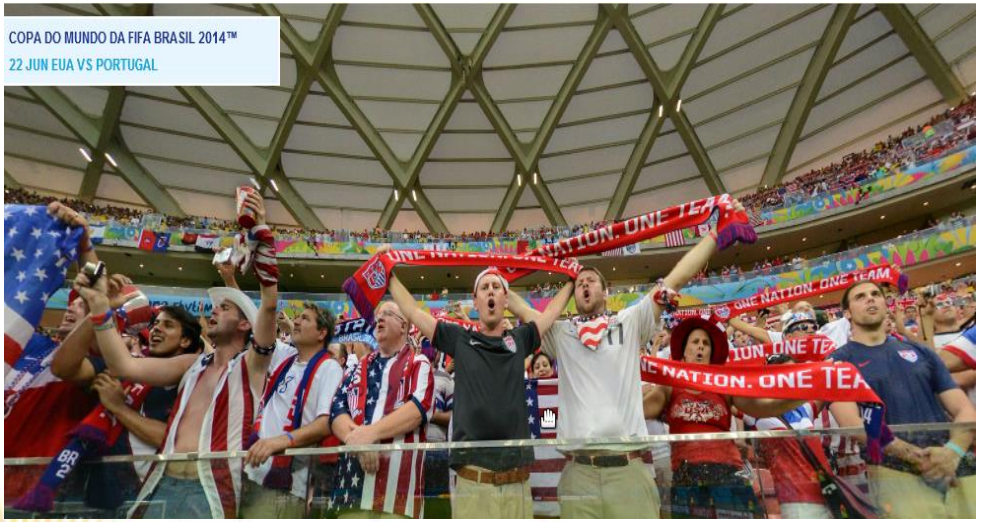
1. Scope changes represent a major risk for owners and contractors
2. Scope changes are harmful for public works – agencies cannot get funds in due time
3. Projects must be budgeted for time and money contingencies – this is difficult for public agencies
4. Adverse weather, low-skilled labor, shortage of workers, complicated logistics and frequent change orders can only be mastered by an exhaustive process of planning and control
5. Lean construction is suitable for repetitive works

Cost Overrun in the 12 Stadiums



FIFA World Cup 2014 Brazil – Manaus





FIFA World Cup 2014 Brazil – Manaus

Manaus received 120,000 tourists, who left
£ 325 million in the city

Matches

England vs Italy  

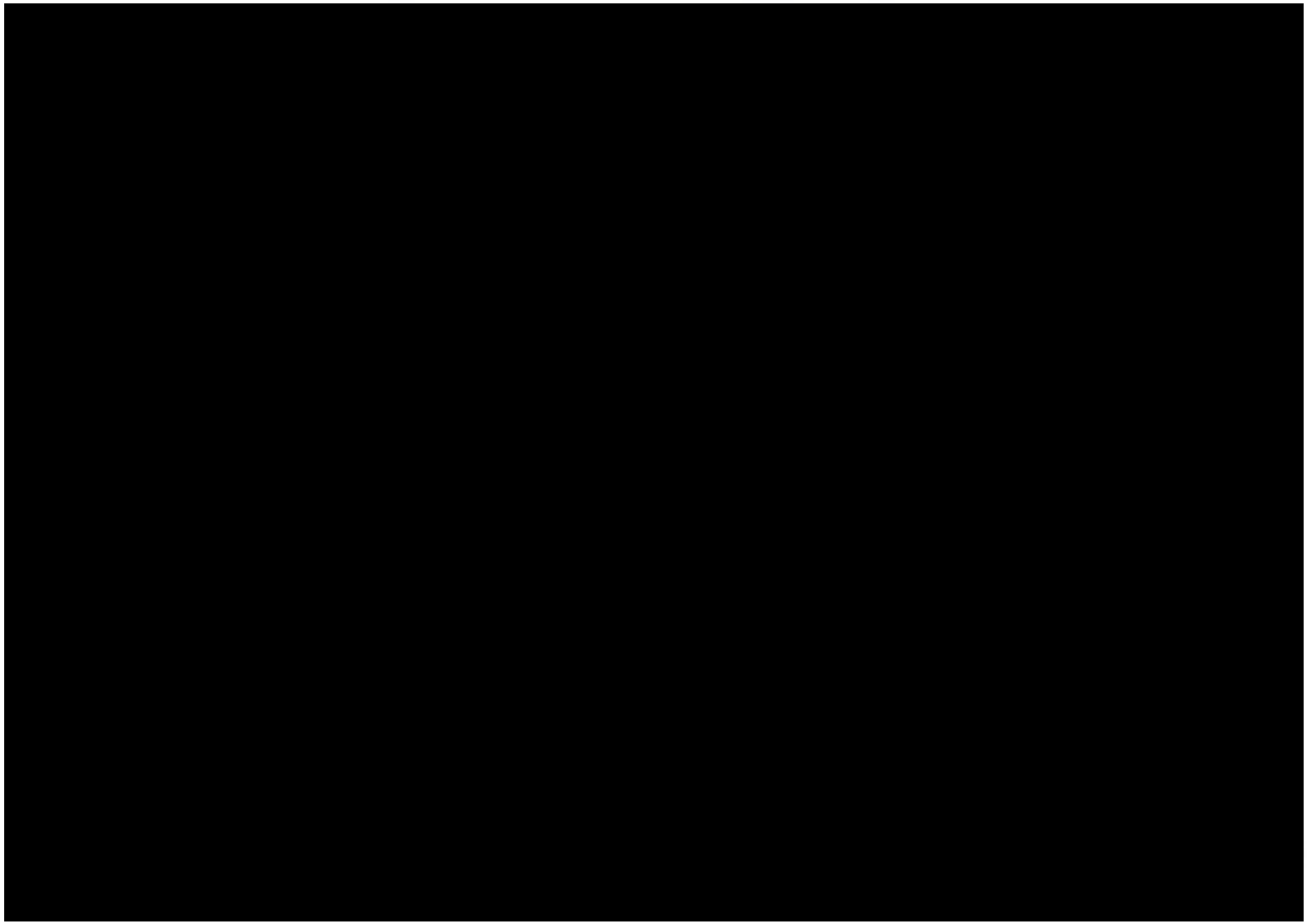
Cameroon vs Croatia  

USA vs Portugal  

Honduras vs Switzerland  

FIFA WORLD CUP Brasil

First GOAL – ITALY!!!



See you in Russia 2018!

Aldo Mattos

www.aldomattos.com
aldo@aldomattos.com