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LOT #135

Lidar Enable Wind Turbine

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BID-ASK™ MARKET

Technology Proposal for LIDAR-enabled Wind Turbine CapEx Reduction

Inventor: Steve Taber

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Steve Taber

Widely known and respected entrepreneur, innovator, and strategic thinker in renewable energy. Co-founder & CEO of Princeton Energy Group, developer of renewable energy and energy efficiency projects worldwide. Co-founder & former CEO of Nordic Windpower, deployer of innovative wind turbine topology, funded by Goldman Sachs SSG. Responsible for numerous innovations in wind and solar energy and in energy efficiency, in the areas of technology, financing techniques, measurement techniques, and business models. Leader in public policy formation and NGO work in energy & environmental/habitat protection. Studied at Princeton, received the Master of Architecture (Phi Beta Kappa) from UC Berkeley, English-Speaking Union Fellow.

The Value Proposition

- LIDAR is a powerful technology, but not positioned optimally in the industry.
- This technology proposal captures the full value of LIDAR to the turbine manufacturer and to the turbine owner.
- The proposed technology is protected by US patent US8538735B2.
- Potentially a valuable strategic IP tool for:
  - Wind turbine manufacturers and designers seeking CoE advantage against competitors in the US market.
  - LIDAR companies seeking to make their technology compelling to turbine makers.

LIDAR: Light Detection and Ranging

Prior Art

- The operation of wind turbines is managed by an on-board controller, which is informed by an anemometer sitting on top of the nacelle, behind the rotor. The controller instructs the turbine to adjust its operating parameters (yaw, blade pitch, etc.) in response to changing wind conditions, in order to reduce stress on the components and thereby reduce O&M cost.
- Because this response requires a few seconds, the turbine is always a few seconds out of phase with the wind.
- LIDAR reads wind conditions a few seconds upwind, eliminating this discrepancy, thereby reducing O&M cost, the primary determinant of OpEx.

Proposed Technology

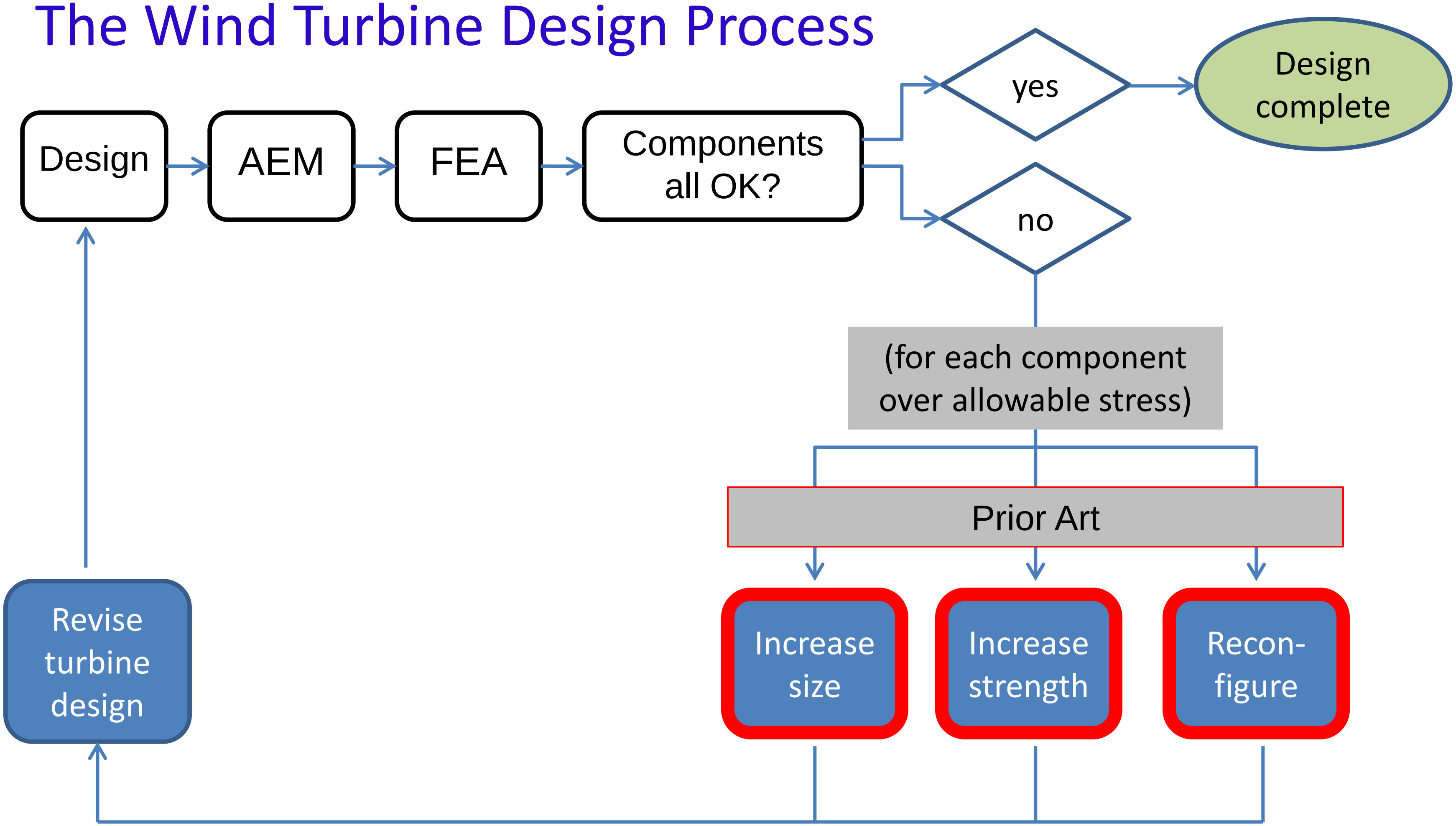
- However, the primary determinant of wind CoE is CapEx (≈90%), not OpEx (≈10%). LIDAR, as currently deployed, is aiming for OpEx, the shallow end of the value pool.
- This technology proposal back-integrates LIDAR capability into the wind turbine design and production process, enabling significant savings in CapEx.
- In essence, this technology proposal enables wind turbines to be lighter and made of less expensive materials, while still meeting all operating requirements. A wind turbine equipped with LIDAR and enabled by this invention does not need to withstand the most severe operating conditions; it can escape them by using its LIDAR capability to shed load. Think sailboats, not ocean liners.

CoE: Levelized Cost of Energy Produced

The Wind Turbine Design Process

- Wind turbines are designed to meet a wide range of operating conditions.
- These conditions (typically several 100 of them) are stipulated by the certifying agency to cover wind speed, wind direction, upflow angle, grid condition, etc., plus the rate and extent of change in each.
- The wind turbine must maintain structural integrity in all the design conditions, in all failure modes (compression, tension, shear, moment, deflection, fatigue).

The Wind Turbine Design Process

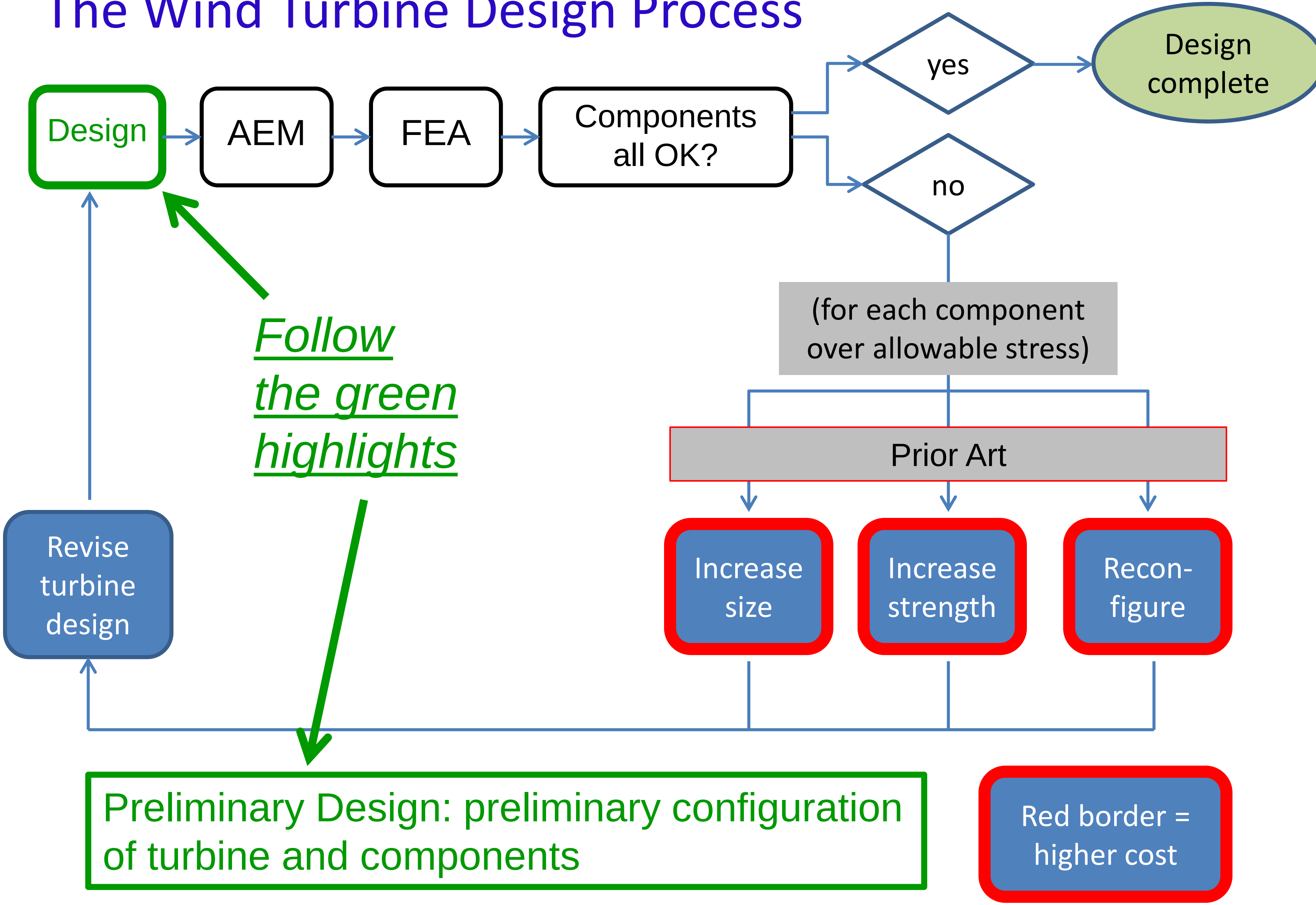


See following slides for detailed explanation.

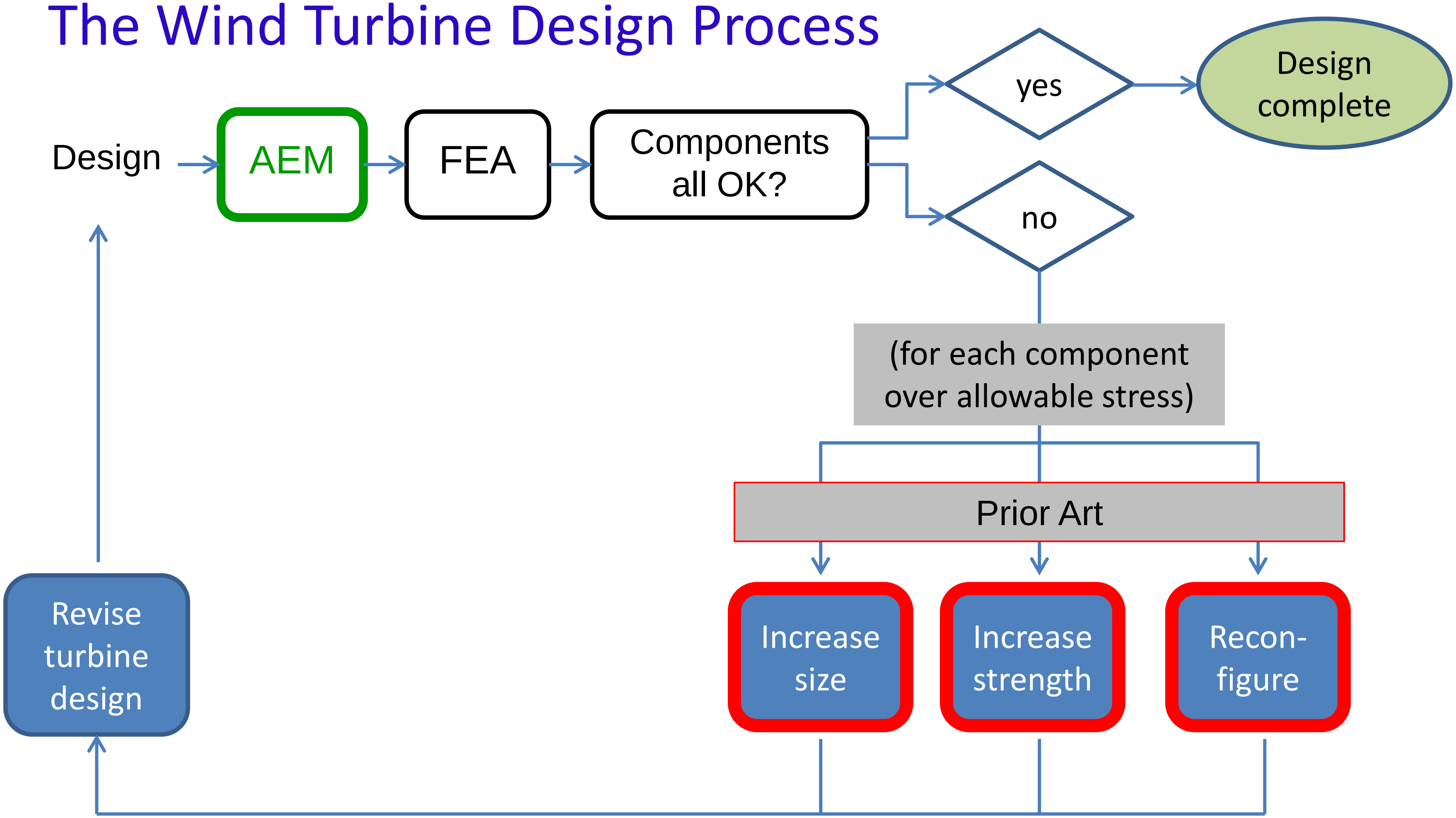
Red border = higher cost

AEM: AeroEleastic Model
FEA: Finite Element Analysis

The Wind Turbine Design Process

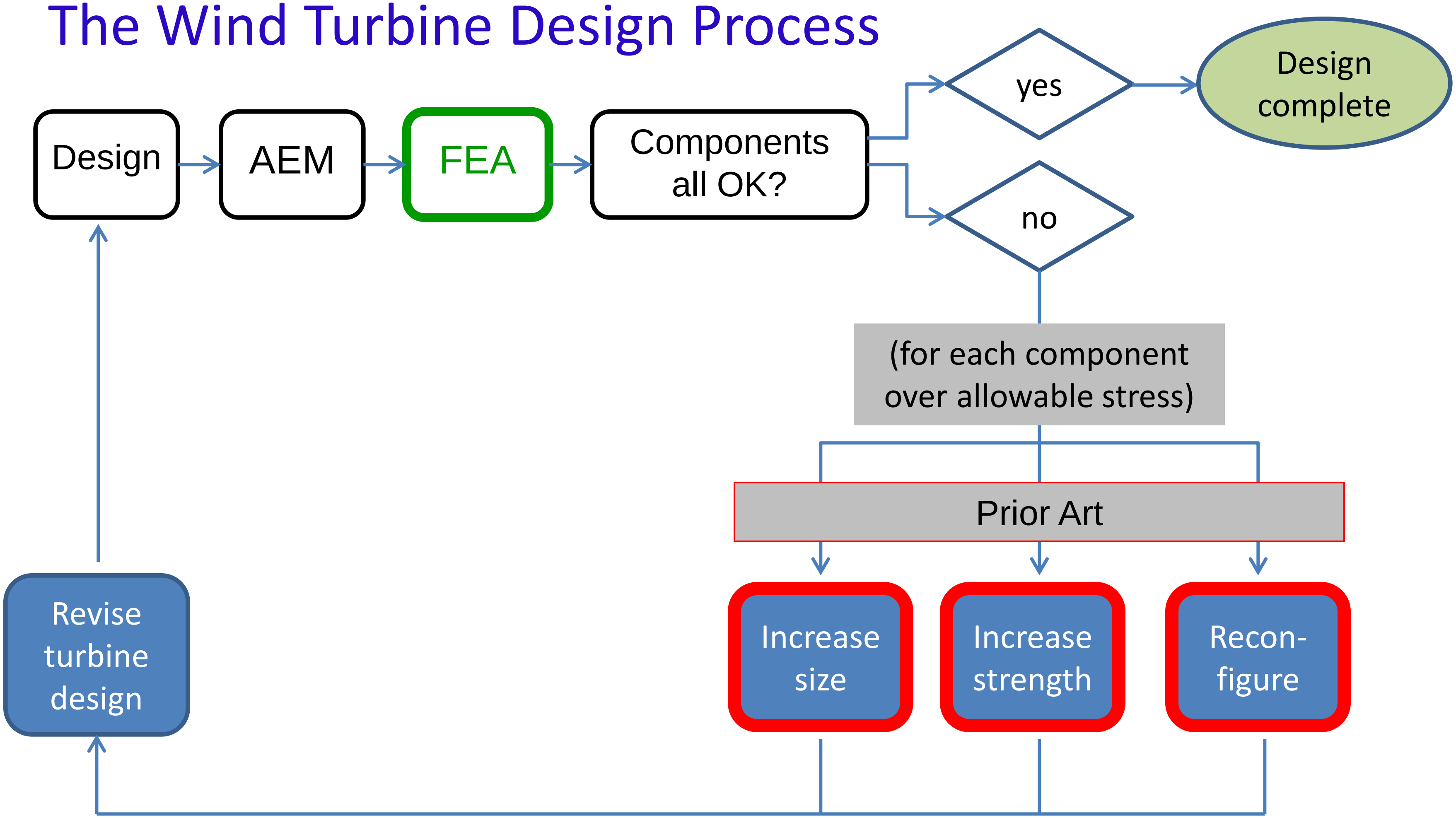


The Wind Turbine Design Process



Aeroelastic model: determine the structural loads on the wind turbine in a stipulated set of operating conditions.

The Wind Turbine Design Process



Finite Element Analysis: determine stress on each component in all failure modes

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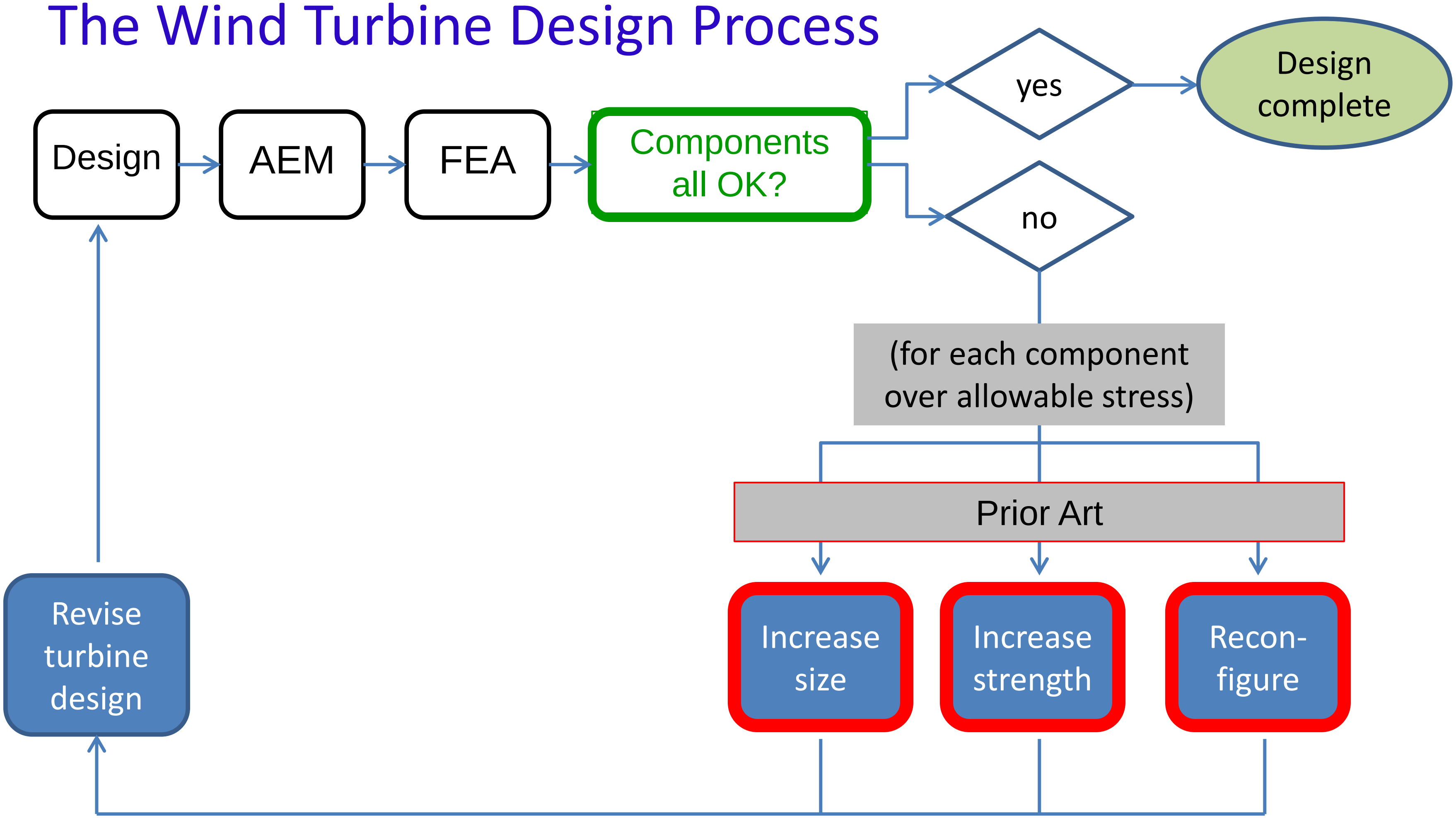
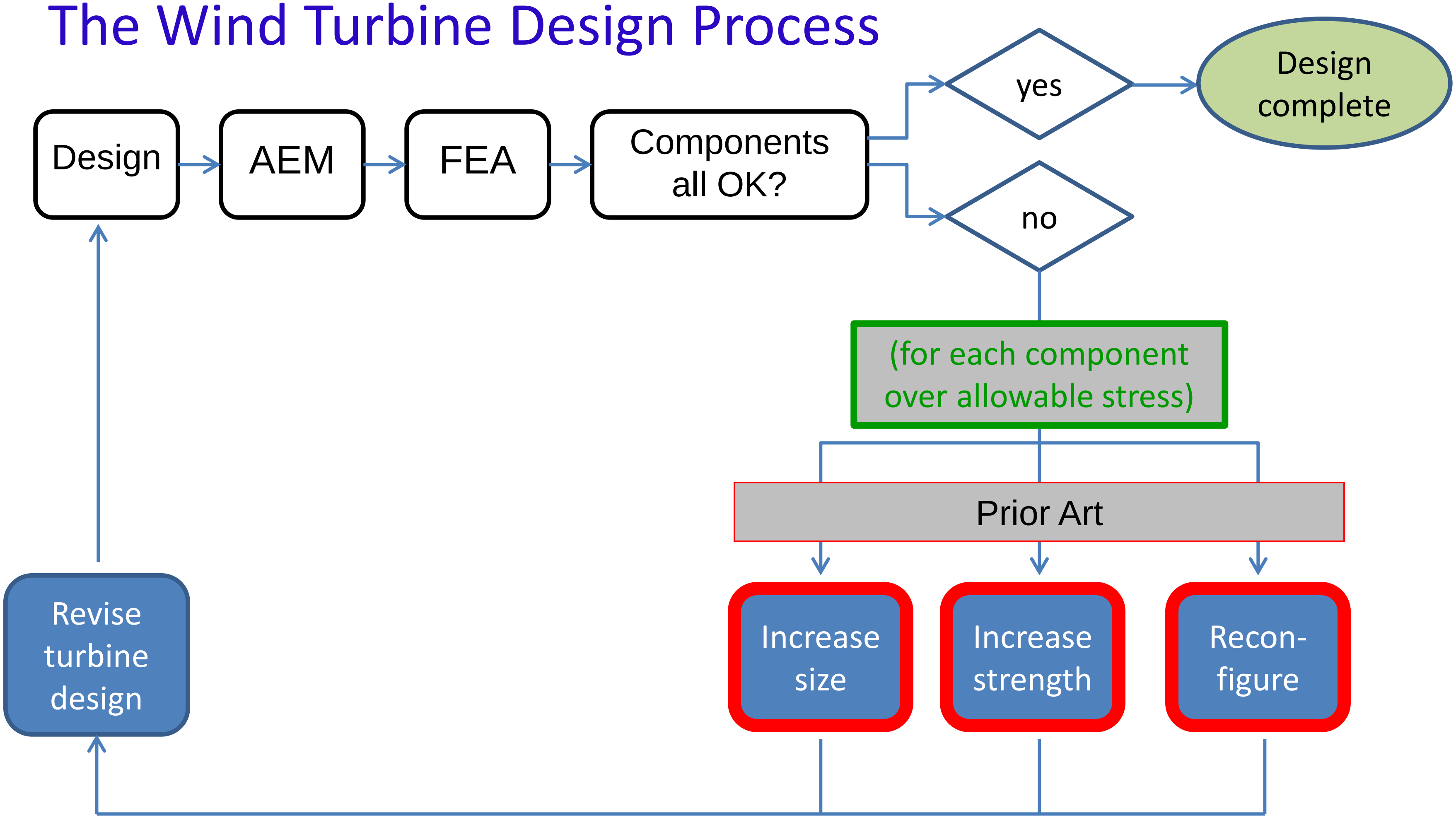
The Wind Turbine Design Process



Are all components within allowable stress in all failure modes?

Red border = higher cost

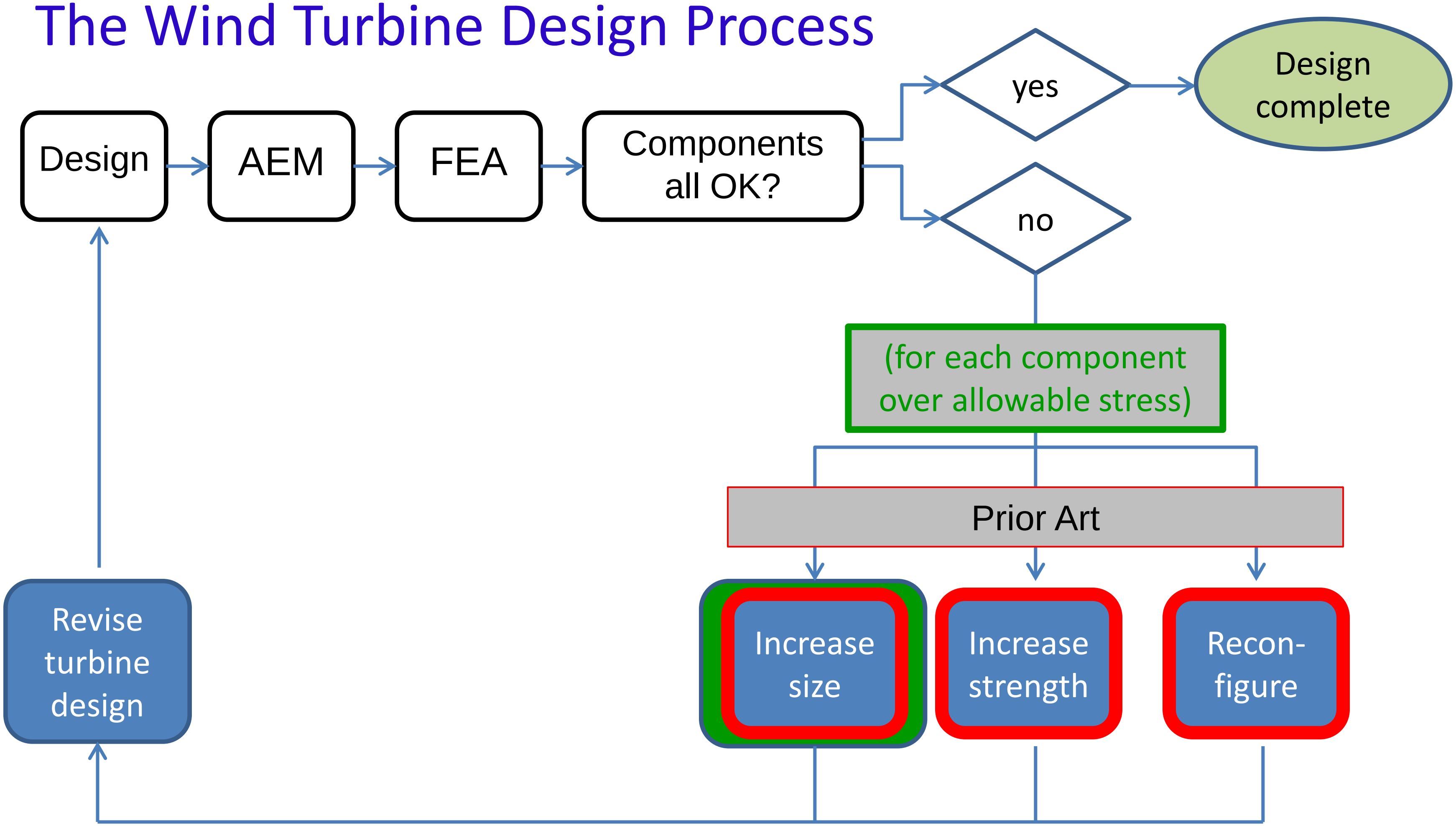
The Wind Turbine Design Process



For each component that is overstressed in any failure mode, the designer now has three options:

Red border = higher cost

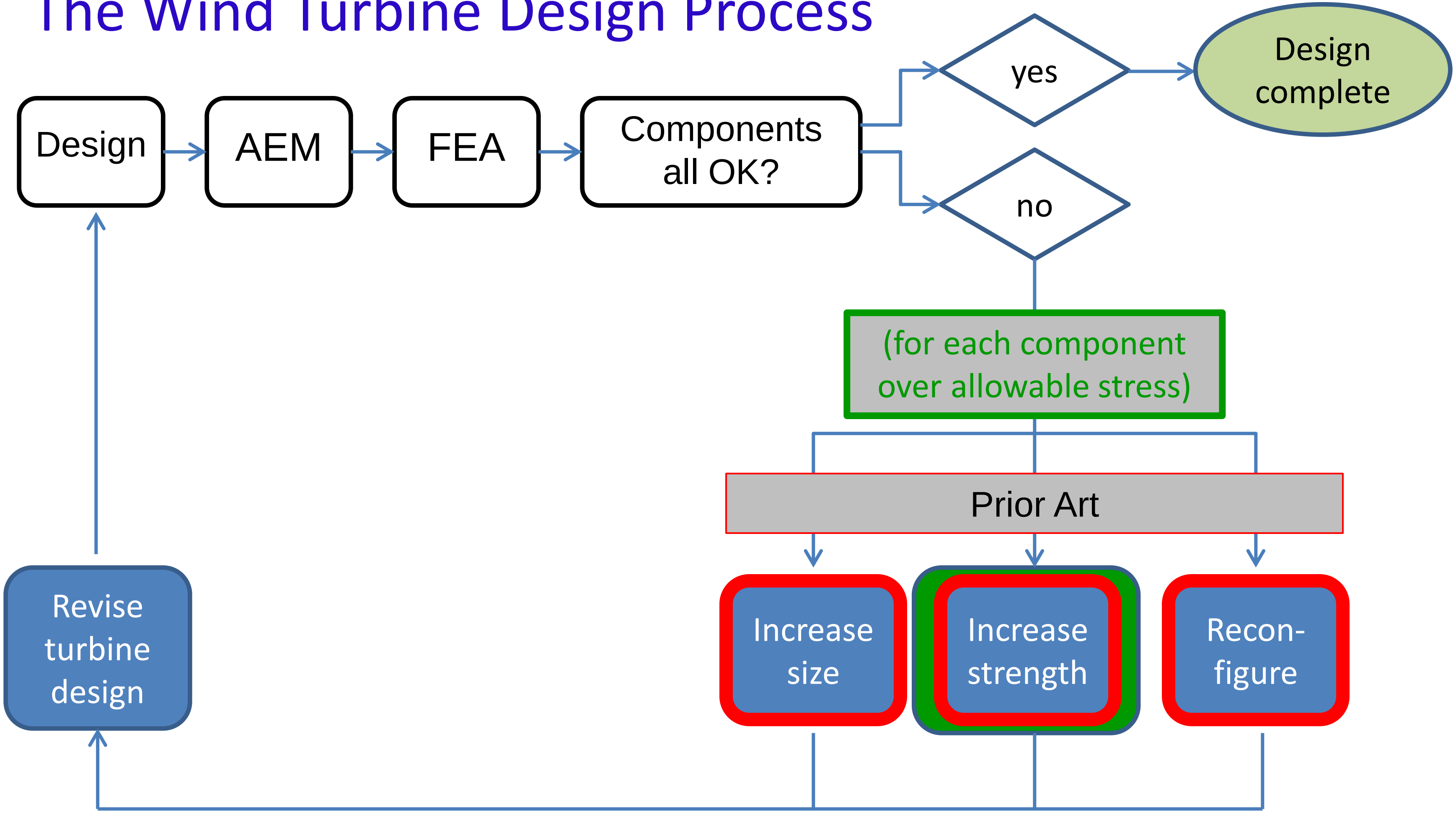
The Wind Turbine Design Process



Option 1. Increase the size of the component, at added cost. This increases the load on other components.

Red border = higher cost

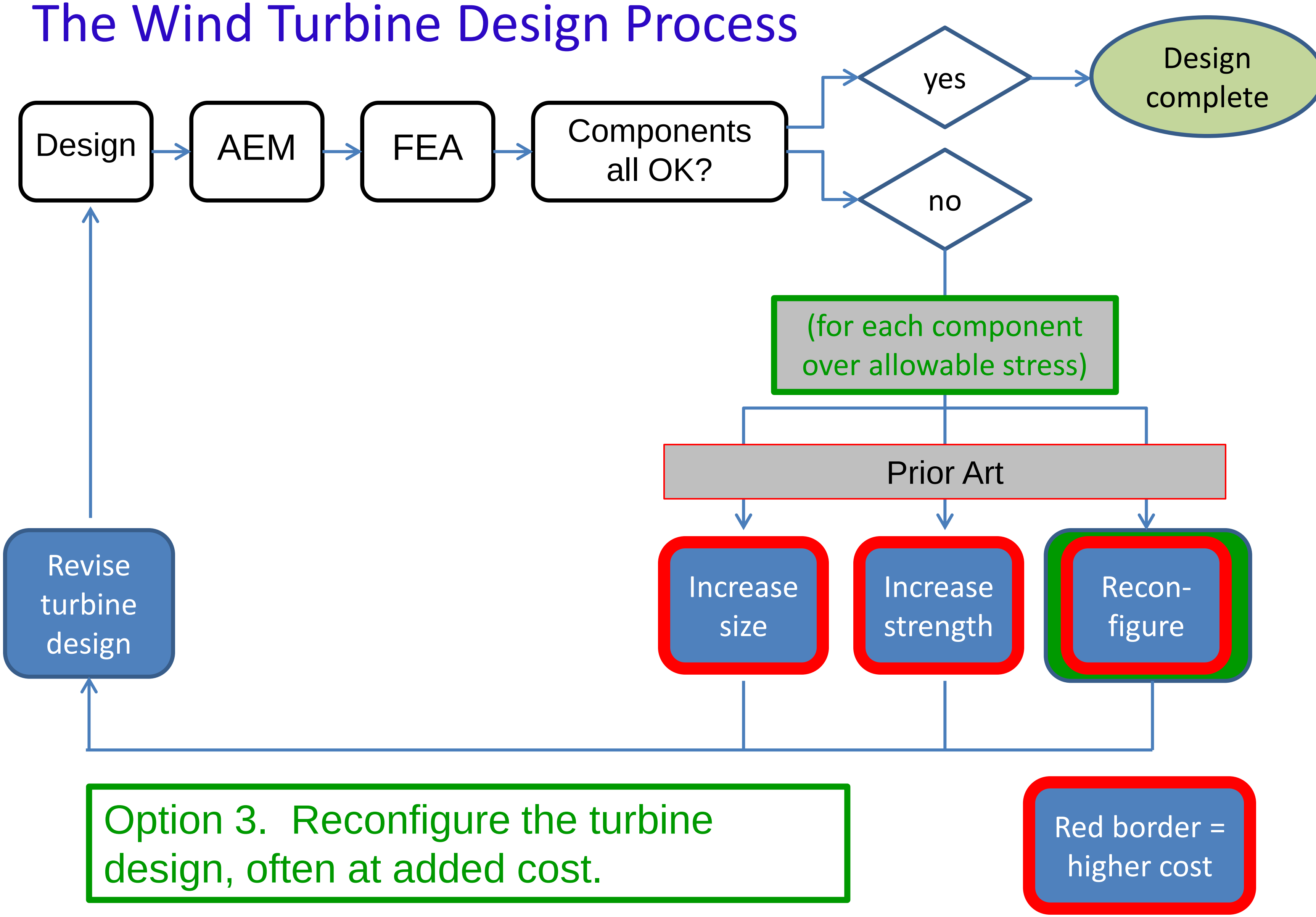
The Wind Turbine Design Process



Option 2. Increase the material strength of the component, at added cost.

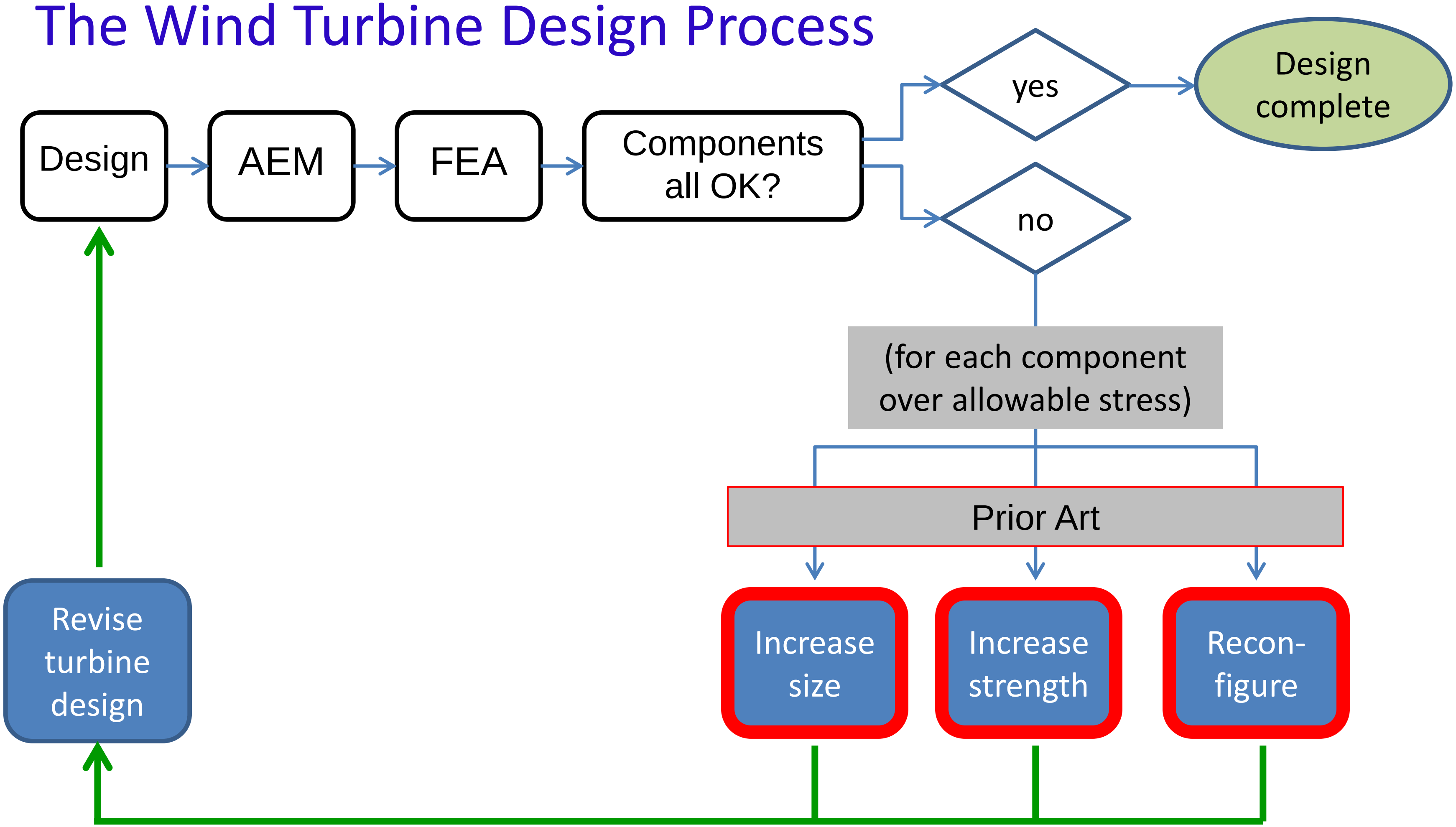
Red border = higher cost

The Wind Turbine Design Process



Option 3. Reconfigure the turbine design, often at added cost.

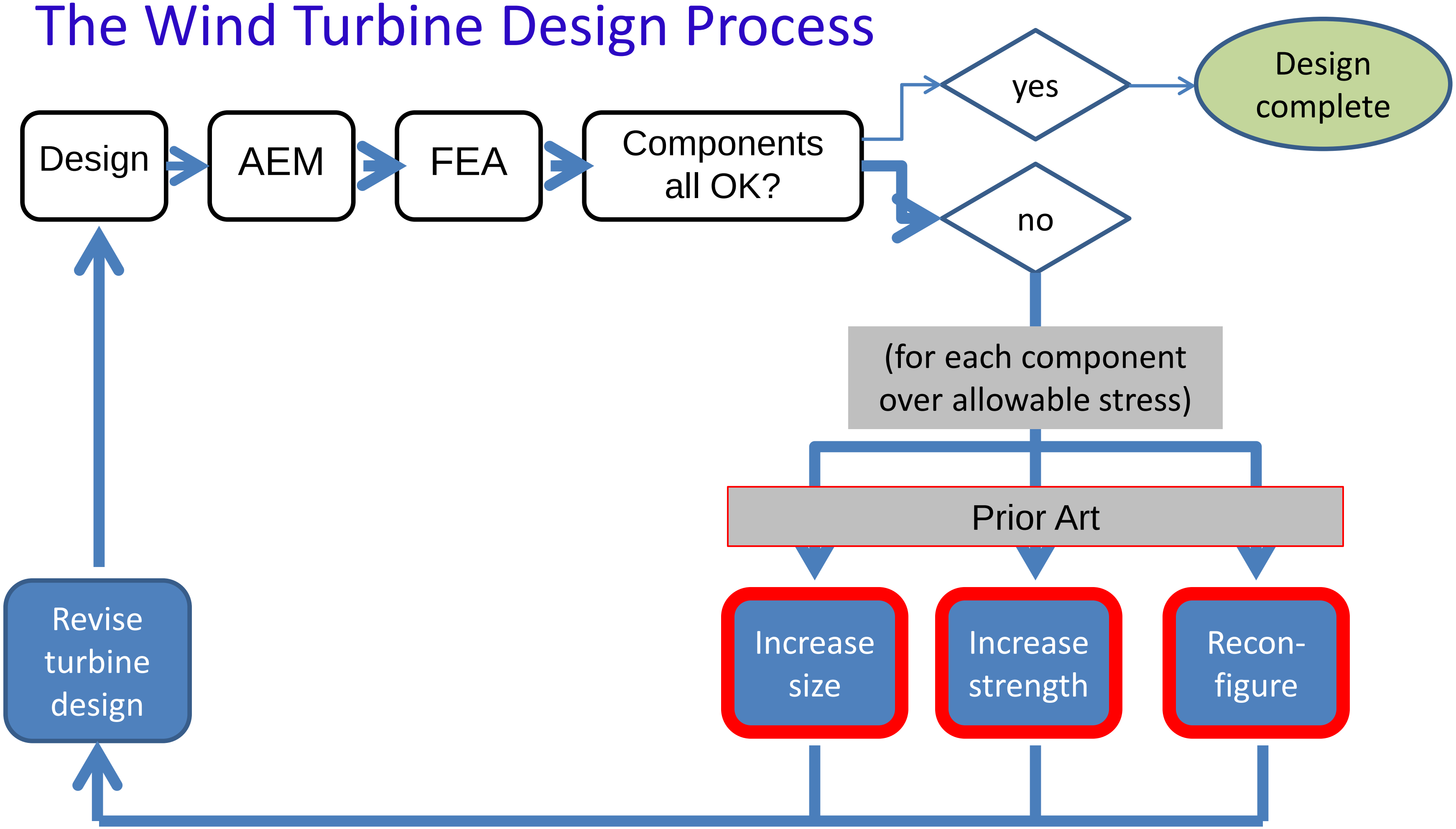
The Wind Turbine Design Process



All three options require a redesign of the turbine and a repeat through the AEM/FEA cycle.

Red border = higher cost

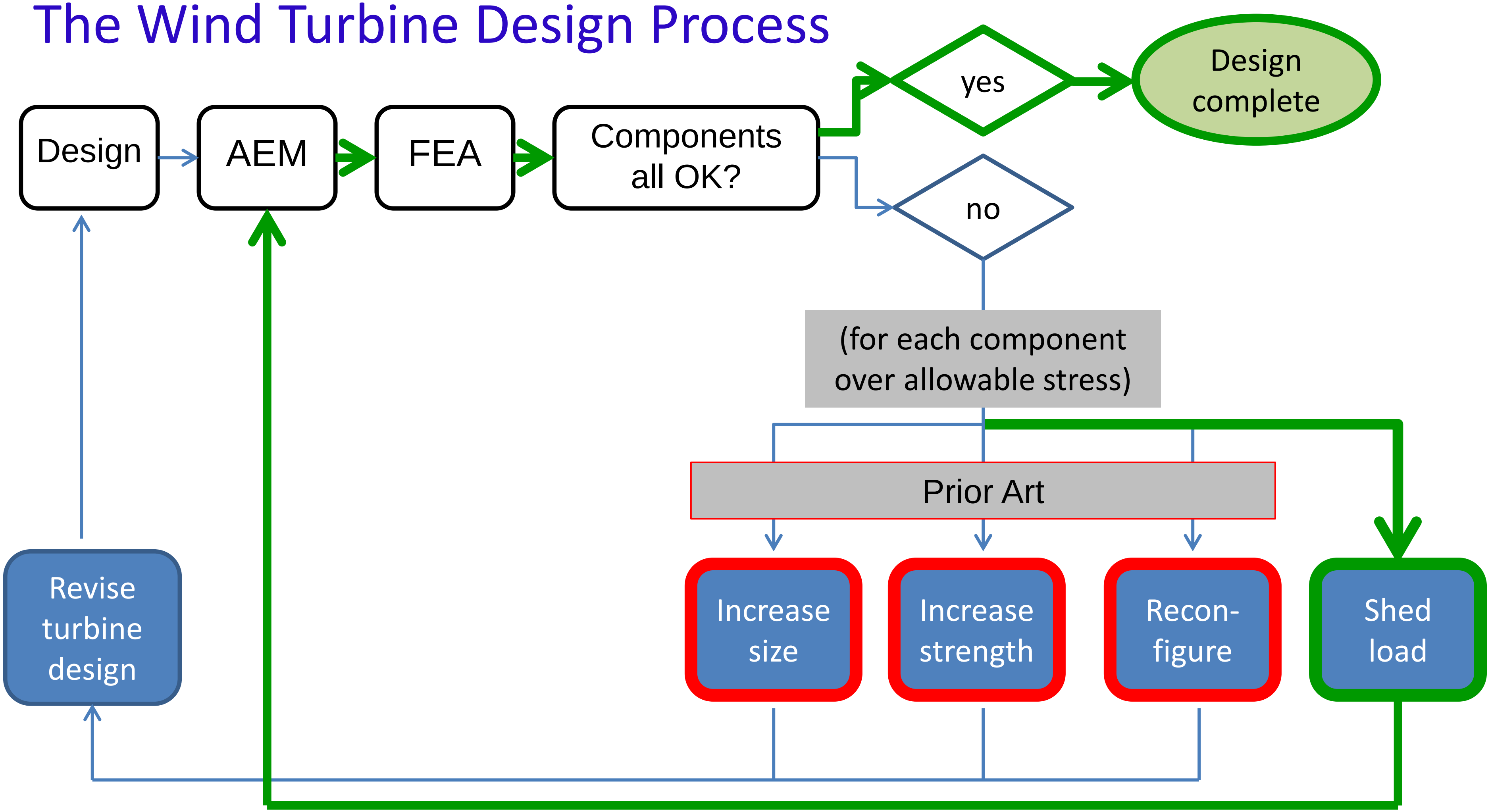
The Wind Turbine Design Process



Wind turbine design typically requires 10s or 100s of design cycles, looping through the AEM/FEA steps

Red border = higher cost

The Wind Turbine Design Process

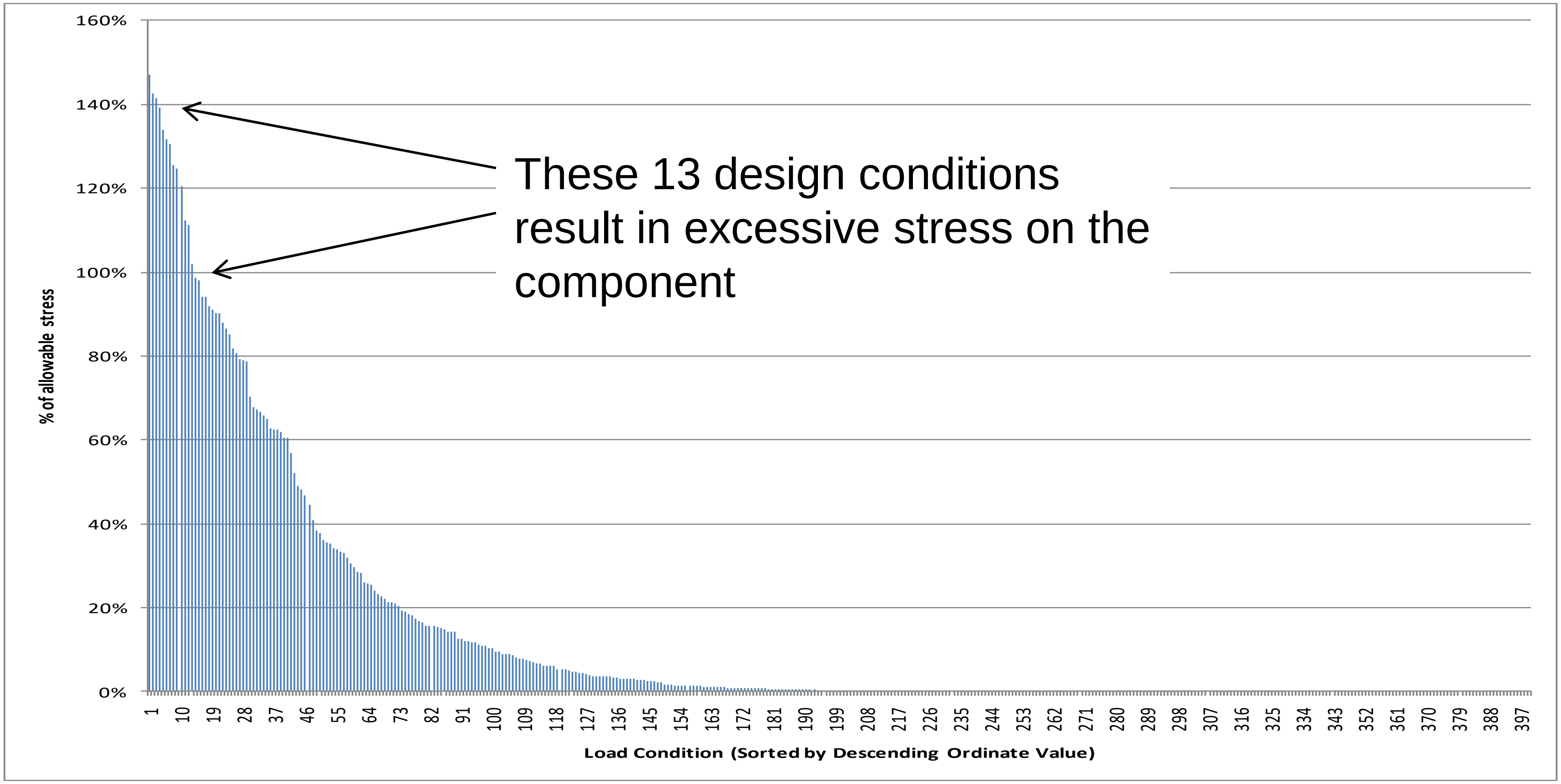


Using the proposed technology, the designer can configure the controller to shed load before it hits the turbine.

The Design Process with the Proposed Technology

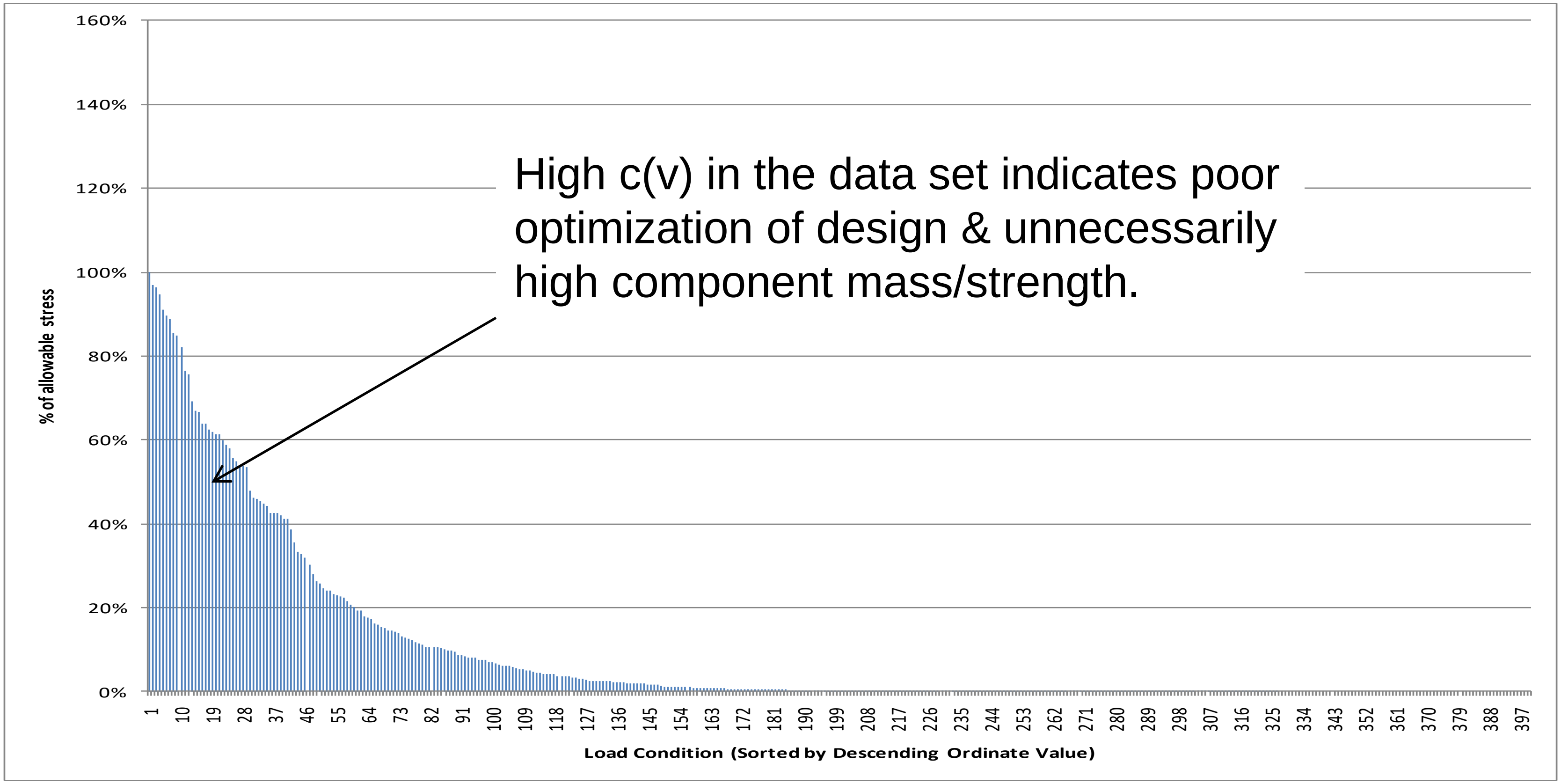
- Using the proposed technology, the designer configures the LIDAR-enabled controller to shed load before it hits the turbine.
- This keeps the maximum stress on the component within acceptable limits *without* increasing the size or strength of the component.
- This greatly reduces the number of design/AEM/FEA cycles, reducing design cost and increasing speed to market.
- This reduces the mass and cost of the component in question.
- Since increased mass in any component increases the loads on other supporting components, and therefore their mass/strength, it also results in a cascade of cost savings through the entire turbine.
- This better preserves the optimization intent of the original design.

For example, this chart shows the range of stresses on a hypothetical component in the full set of design conditions required for certification, after FEA and before redesign.



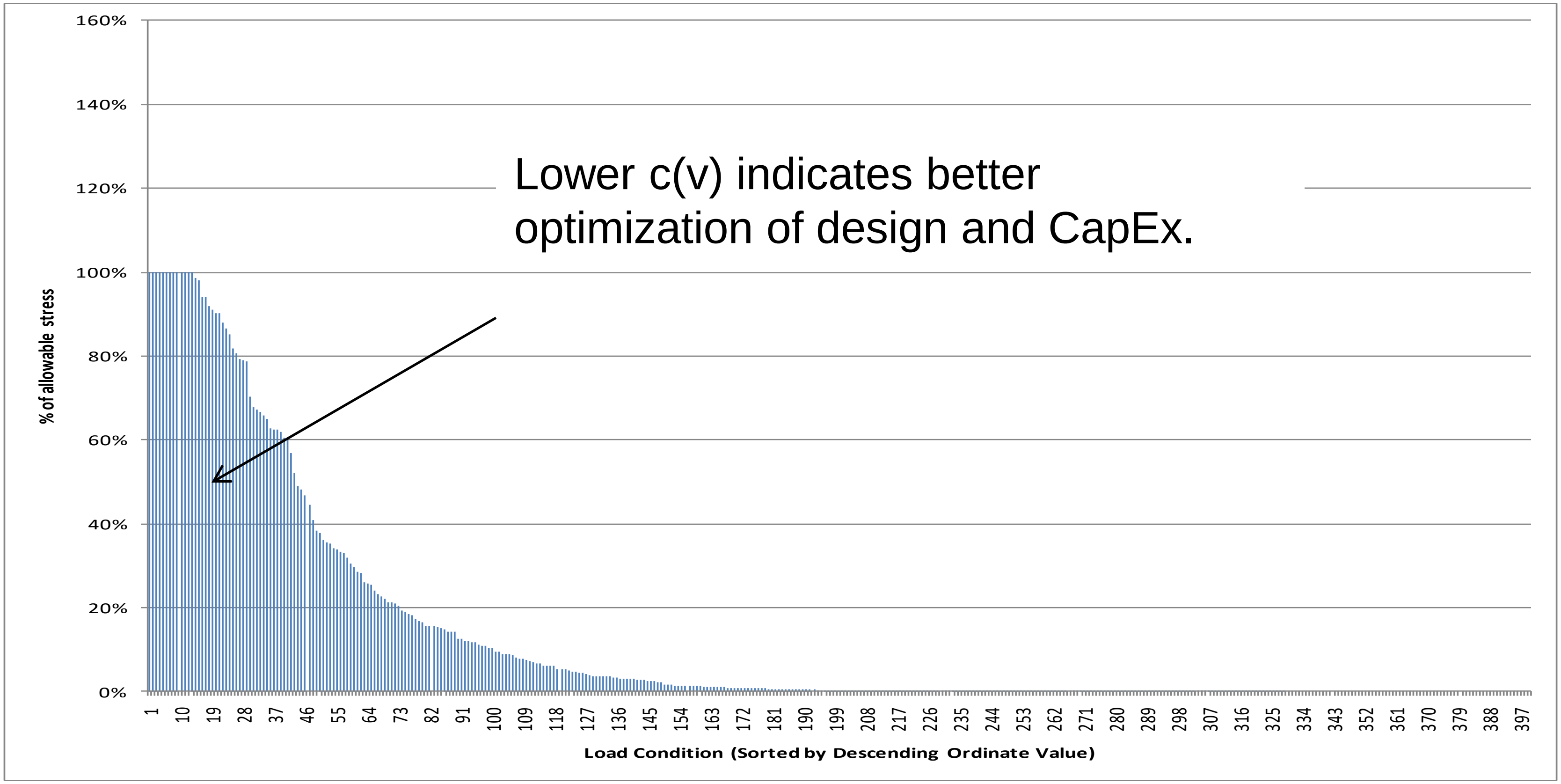
Range of % of Allowable Stress on Subject Component Before Redesign

This chart shows the range of stresses on the component, after FEA and redesign, using prior art. This typically requires numerous cycles of redesign/AEM/FEA.



Range of % of Allowable Stress on Subject Component After Redesign Using Prior Art

This chart shows the range of stresses on the component, using the proposed technology to shed load and avoid redesign.



Range of % of Allowable Stress on Subject Component
With Proposed Technology

Economics of the Proposed Technology

- Reduced Design Time & Cost. Expected savings of a few months of calendar time and ≥ a few $100,000s of engineering cost for each new turbine type introduced to the market.
- Reduced Component Cost. Expected savings of 5-10% of BoM = a few $10,000 per MW.
- Reduced Towertop Mass. Expected reduction of 5-10%. This reduces the required mass/strength of the tower and foundation, reduces required crane capacity, and reduces transportation cost.
- Overall, 5-10% reduction in wind turbine CapEx is expected.
- Wind generation is a fairly mature technology; wind turbines are procured as a commodity, based on CoE. ≈90% of CoE is driven by CapEx. Therefore, the 5-10% CapEx advantage of the proposed technology is commercially very powerful.

Portfolio Summary

- Ocean Tomo Bid-Ask™ Market patent auction lot 135 offers one U.S. patent that discloses leveraging fluid movement data using LIDAR or SODAR into the wind turbine design and operational process, enabling significant savings in CapEx.

- The patent has a remaining life of 12 years and an earliest priority date in 2009.

- The present technology uses fluid movement data at a point upstream to a turbine in order to estimate fluctuations and modify operational characteristics of the turbine accordingly.

- The resulting operational optimization of the turbine both maximizes turbine power generation and reduces operational stress on the turbine components.

- This portfolio would be a valuable strategic IP tool for wind turbine manufacturers seeking advantages against competitors in the US market, and LIDAR/SODAR companies seeking to gain traction with turbine manufacturers.

Thank you very much

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Bid 竞价	Price Spread 价差
Ask 要价	Sold 成交
In Market (Lot Will Sell) 待拍品	Transaction Pending

DOCUMENT PROCESSING SYSTEM
用户界面
SOLD
LOTS: 64 专利拍品数量 SOURCE CODE 源代码
9 ASSETS 专利数量

DIGITAL DISPLAY SYSTEM
数字内容访问
LOT: 65 专利拍品数量
4 ASSETS 专利数量

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OCEAN TOMO全球专利在线竞价交易市场
TOUR THE MARKET
市场一览

INDUSTRIAL INTERNET SECURITY & INSPECTION
一种工业互联网安全和检查的装置
LOT: 66 专利拍品数量 SALE 出售 LEASE
21 ASSETS 专利数量

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18

LOT NUMBER 拍品编号	DATA ROOM 数据服务室	PTO 知识产权局	NICKNAME 拍品名称	REPRESENTATIVE PATENT 专利	PRIORITY DATE 优先权日期	EVENT DATE* 活动日	BID USD/RMB* 竞价	BID EXP. DATE 竞价截止日	ASK USD/RMB* 要价	ASK EXP. DATE 要价截止日	PRICE SPREAD 价差	ASSETS 资产
03-ZHA-74-18		US	Data Processing 一种数据处理方法	US9047283	1/29/10	3/28/18			$3,800,000 ¥ 24,062,360.00	9/28/18		38

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