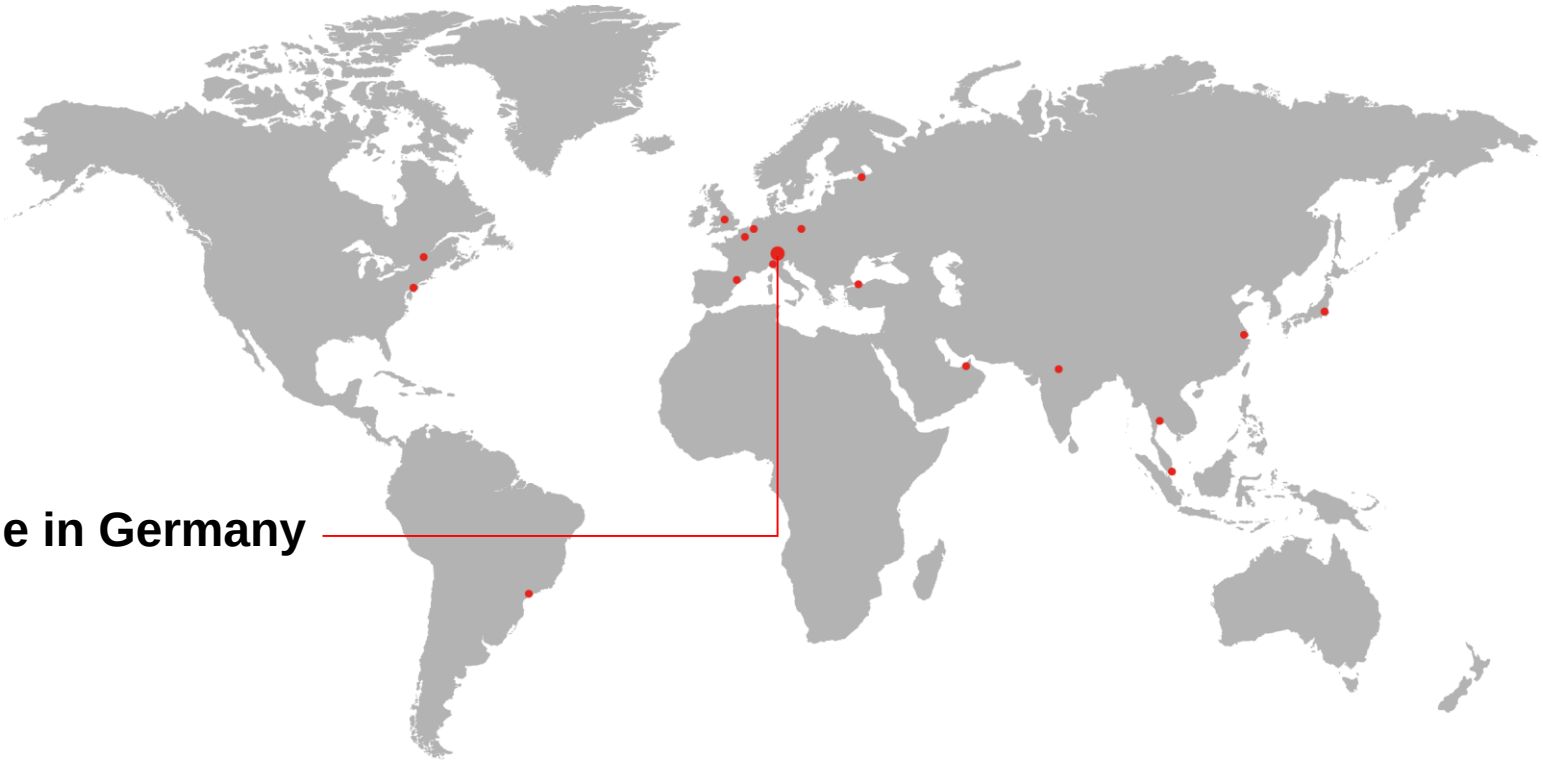
Bearing Reliabilty Conference & Expo

22. – 23. March 2016

Markus Brotsack

PRÜFTECHNIK

Facts and Figures



Made in Germany

1972 **Founded by Dieter Busch**

600 **Employees Worldwide**

18 **Sales & Service Subsidiaries**

Belgium/Netherlands, Brazil, Canada, China, France, India, Indonesia, Italy, Japan, Middle East, Poland, Russia, Singapore, Spain, Thailand, Turkey, UK, USA

Distributors in

70

Countries

Facts and Figures (2)

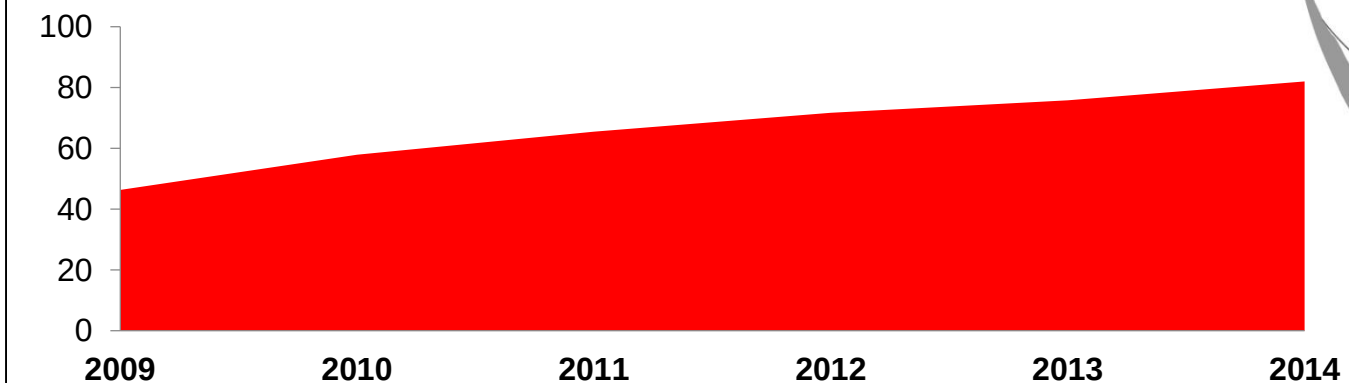
300 Patents Worldwide

150 Trademarks Worldwide

20% R&D

Sales 2014 **82** €M

Revenue in €M



Company Activities

Our Mission

- To be a leading single source provider of premier measurement and monitoring solutions for plant maintenance and quality assurance.

Our Core Activities

- Alignment Systems
- Condition Monitoring
- Nondestructive Testing

Laser Alignment Systems

Why alignment?

- Misalignment increases temperature, vibration and loads
- Misalignment increases wear of bearings, couplings, seals and shafts
- Downtime, production losses and mechanical repairs generate high operating and maintenance costs

Our solutions

- Shaft alignment
- Measurement of machine geometry
- Bore alignment
- Monitoring positional changes
- Roll alignment with PARALIGN

Benefits of alignment

- Longer service life
- Increased MTBF and uptime
- Lower power consumption
- Reduced temperature, vibration and mechanical repairs
- Lower operating costs
- Higher product quality

Condition Monitoring

Why Condition Monitoring?

- Reduced machine lifetime due to excess vibration and loads
- Reduced machine availability due to unplanned shutdowns
- Increased operating costs
- Unavailability of machine health data for CbM or asset reliability

Our solutions

- Portable data collectors and analyzers
- Online Condition Monitoring
- Continuous wear monitoring
- Machine protection
- Monitoring Services
- Certified Monitoring Center

Benefits of Condition Monitoring

- Early detection of machine problems
- Elimination of root cause before failure occurs
- Reduced vibration and wear
- Increased machine availability
- Reduced operating costs
- CM feeds CbM and asset reliability programs

Nondestructive Testing

Why NDT?

- Faults in products lower quality and productivity
- Impacts on competitiveness and performance
- Compliance to quality standards is getting tighter

Our solutions

- Eddy current testing equipment
- Flux leakage testing equipment
- Sensors and accessories
- Turnkey systems from design to commissioning

Benefits of NDT

- Improved product quality
- Optimized production processes
- Reduced scrap
- Improved productivity and performance

Worldwide Machinery Services

Laser Shaft Alignment

Turbine Alignment

Machine Condition Monitoring

Roll Alignment

Mobile Measurement

Geometric Alignment

Customer Support

- Worldwide After-Sales Services
- Calibration and Repair
- Certified Monitoring Center
- Telediagnosis
- Remote Mentoring

Worldwide Training

- CAT I-IV vibration training
- Alignment training
- Product training
- Onsite training

Solutions for Manufacturing

We serve maintenance professionals in any industry where rotating equipment is in operation.

Poised for the Future

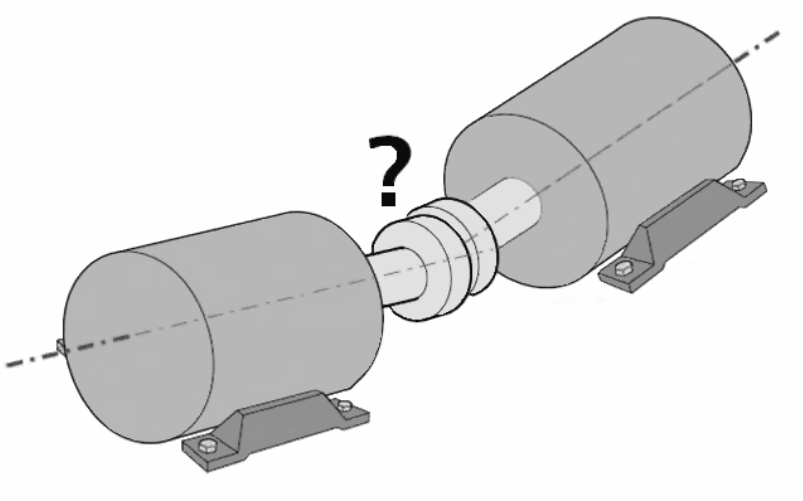
2015:

- Merge of Alignment Systems and Condition Monitoring business units
  - Optimize process efficiency and customer orientation
  - Tight integration of Alignment Systems and Condition Monitoring

Citation:

‚Industry worldwide is losing billions of dollars a year due to misalignment of machinery‘

Source:
John Piotrowski: Shaft Alignment Handbook, CRC Press 2007[3rd]



Agenda:

- Short introduction to LCC
- Costs over lifetime of a pump
- Alignment of a motor pump systems
- Relationship between alignment and costs of operation for a pump
- Effects of misalignment
- Possible savings – a few examples
- Summary
- Examples of alignment in chemical industry
- Contact data

- Literature

LCC → Life Cycle Costs

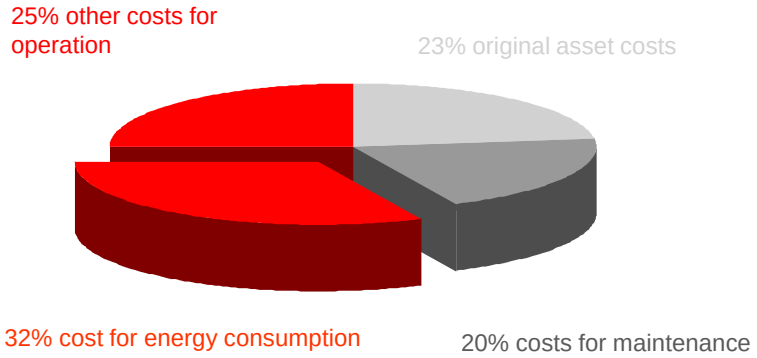
LCC includes following details:

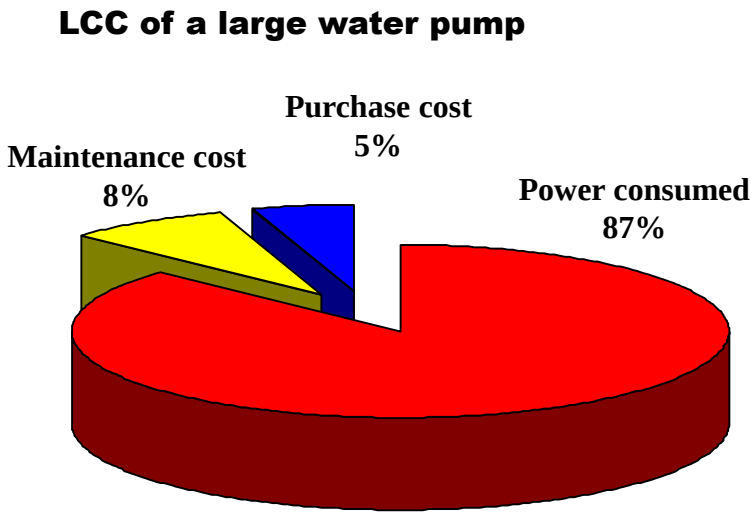
$$\mathbf{LCC = C_{ic} + C_{in} + C_e + C_o + C_m + C_s + C_{env} + C_{cip} + C_{qu} + C_d}$$

Whereas	C_{ic}	→	Original asset costs
	C_{in}	→	Costs for installation
	C_e	→	Costs for energy consumption
	C_o	→	Costs for operation
	C_m	→	Costs for mainteance
	C_s	→	Costs for production downtime
	C_{env}	→	Costs for environmental protection
	C_{cip}	→	Cleaning costs
	C_{qu}	→	Costs for quality improvments
	C_d	→	End of life costs

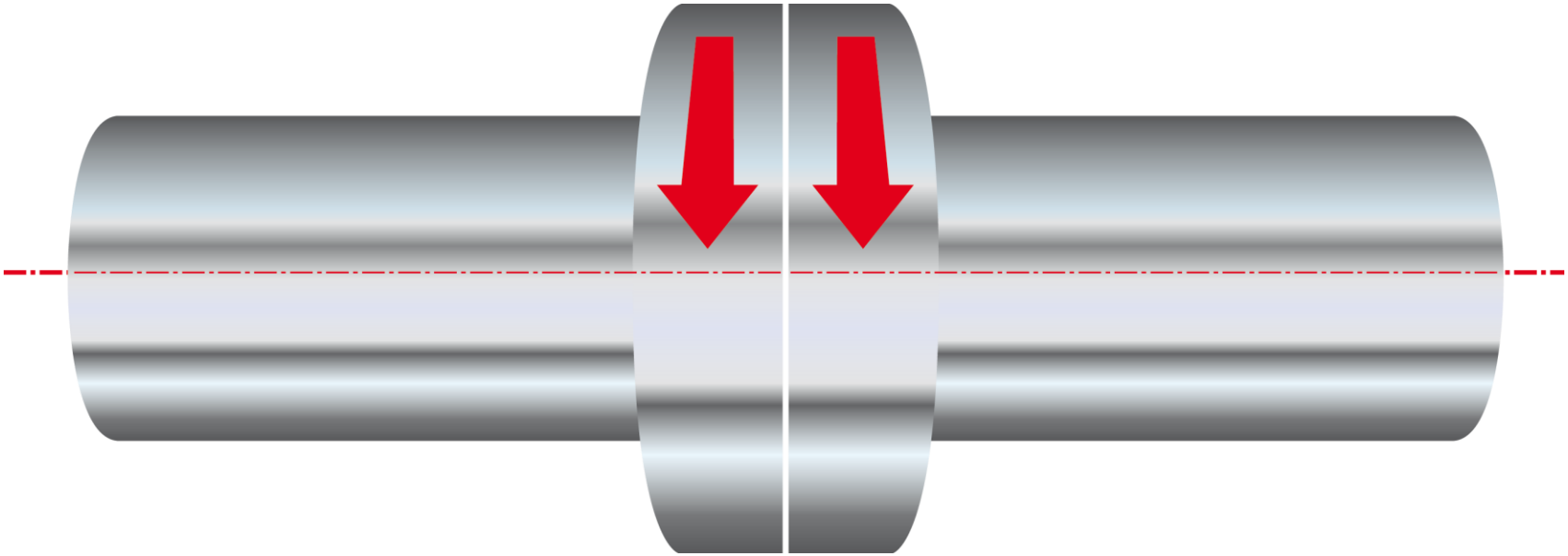
Quelle: dena

Equipment Alignment for Prolonged Life



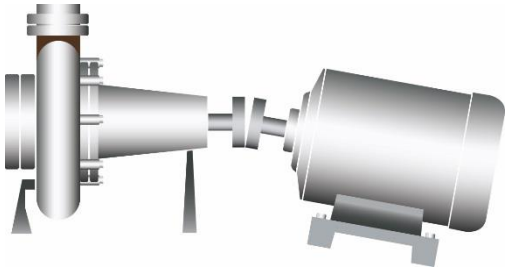


At least 1/3, even up to 4/5, of the LCC are used up for energy, depending on type of pump and application

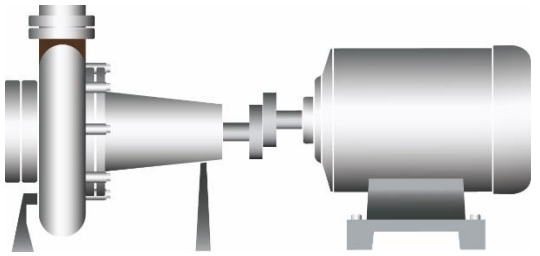


Shafts are aligned, if the two shafts are in line during operation conditions.

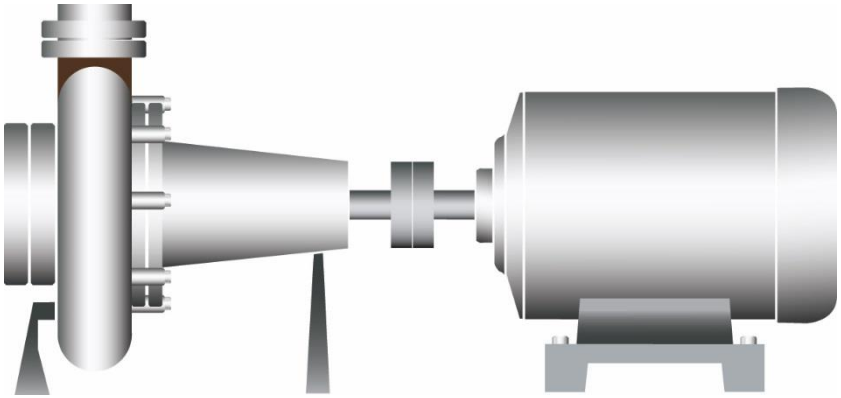
Equipment Alignment for Prolonged Life

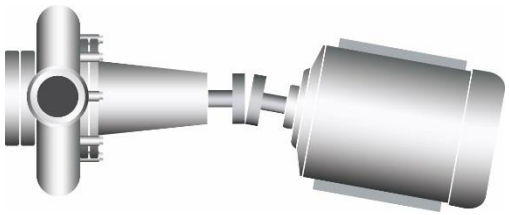


vertical angle

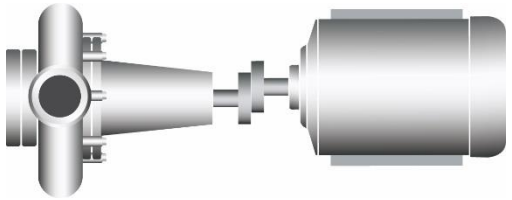


vertical offset





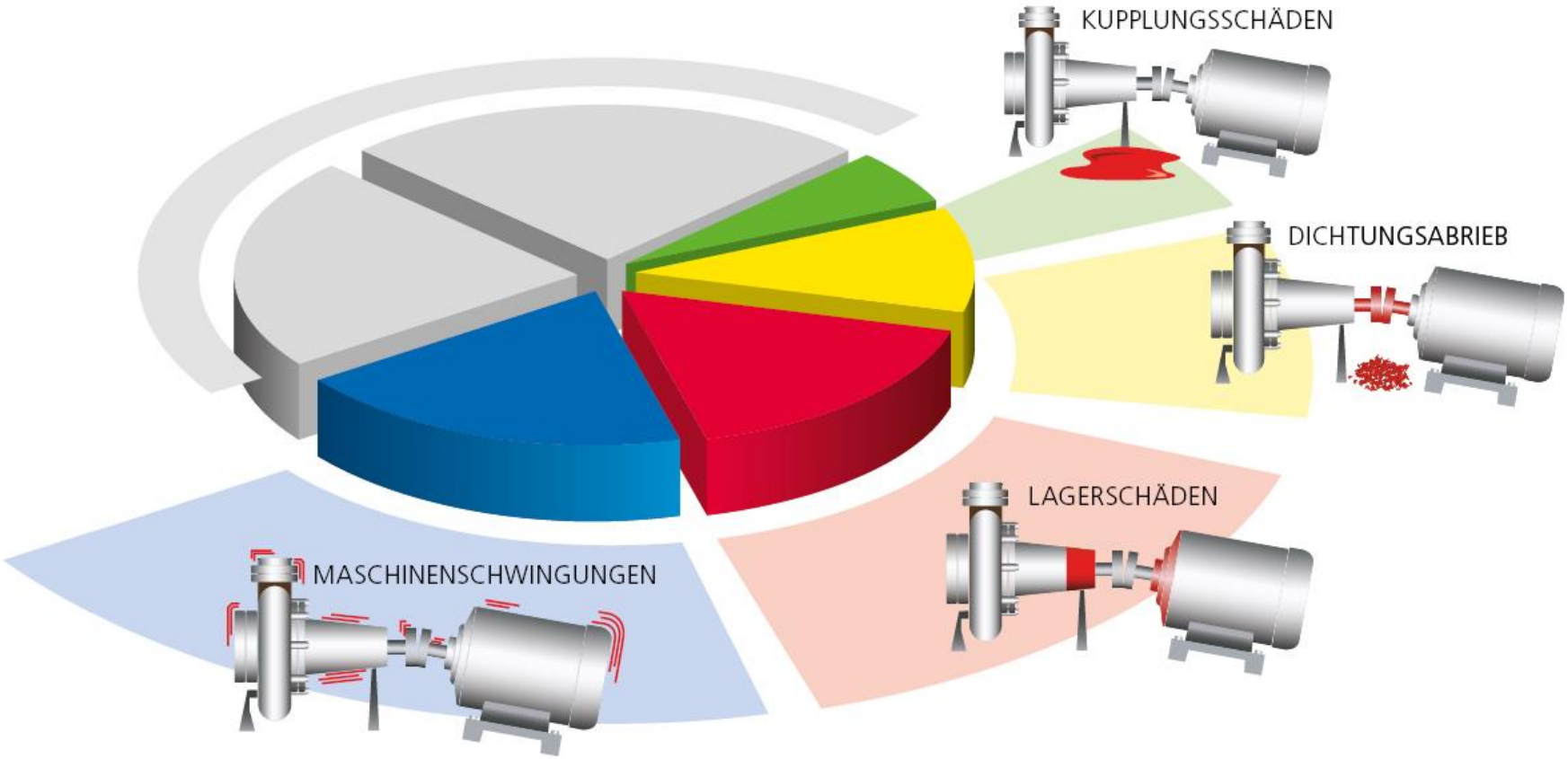
horizontal angle



horizontal offset

Equipment Alignment for Prolonged Life

- Intelligent condition based maintenance on rotating equipment is part of maintenance strategies. This also includes precise alignment of shafts.
- Analyzing the root causes of break down at rotating machinery it is found that over 50% are due to misalignment.



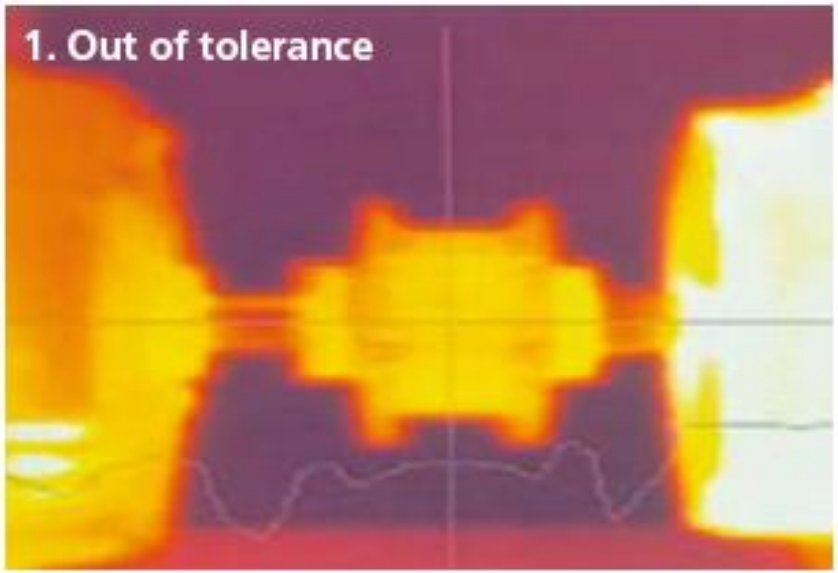
Results of misalignment

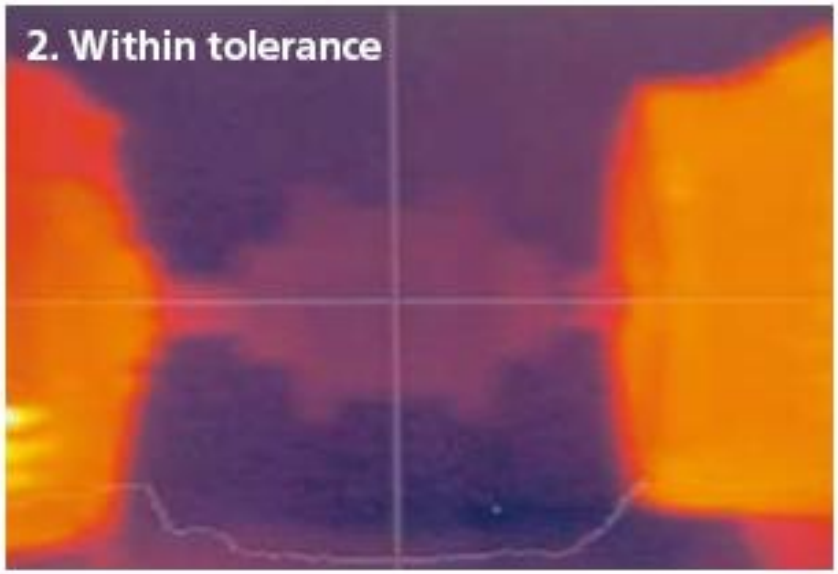
- Increased abrasive wear of following parts:
  - **Bearings**
  - **Seals**
  - **Couplings**
  - **Shafts**
- Reduction of MTBF – Mean Time Between Failure
- Extreme: Noise due to increased vibrations
- Increased power consumption

Signs for a misaligned shaft system:

- Strong radial and axial vibrations
- Strong abrasion at bearings, sealings, couplings and broken shafts (extreme)
- Oil leakage at the bearings
- High temperature at bearings and couplings
- Loosing of bolting
- Increasing energy consumption
- And others more …

Example: Increase temperature at coupling and Bearing of a motor pump systems (infrared image)

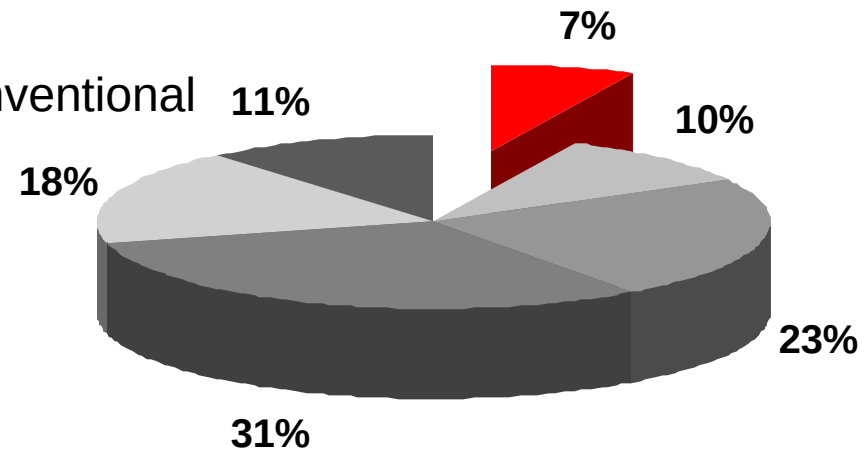




The reality concering alignment in industry:
Example of a chemical company, England

- 160 randomly chosen machines
- 3.000 rotations per minute
- Machines have been aligned with conventional method (dial gauge / straight edge)

Offset (mm)	Measured machines
0,00 – 0,05	7% acceptable alignment
0,06 – 0,10	10% out of tolerance
0,11 – 0,20	23% out of tolerance
0,21 – 0,50	31% out of tolerance
0,51 – 1,00	18% out of tolerance
> 1,00	11% out of tolerance

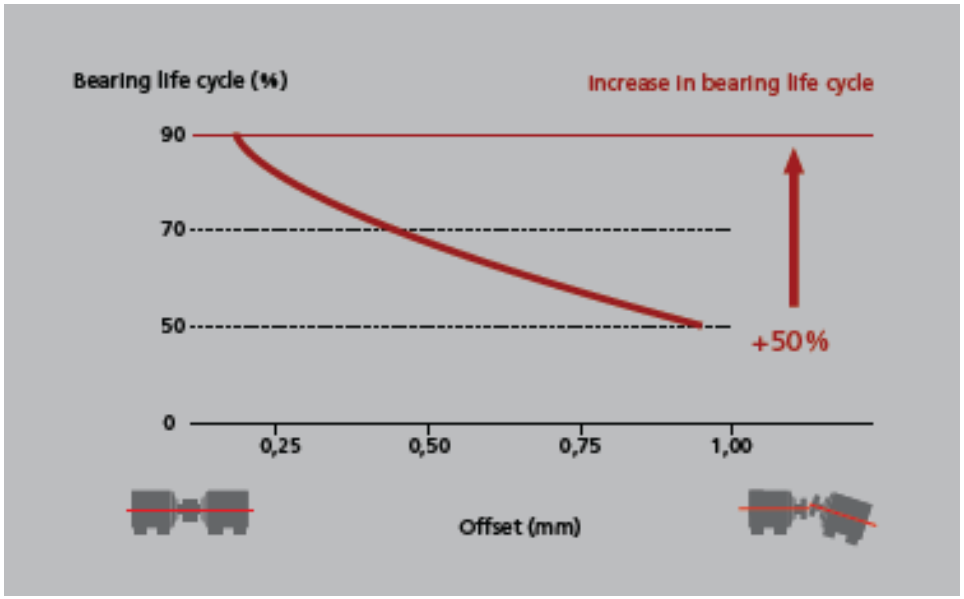


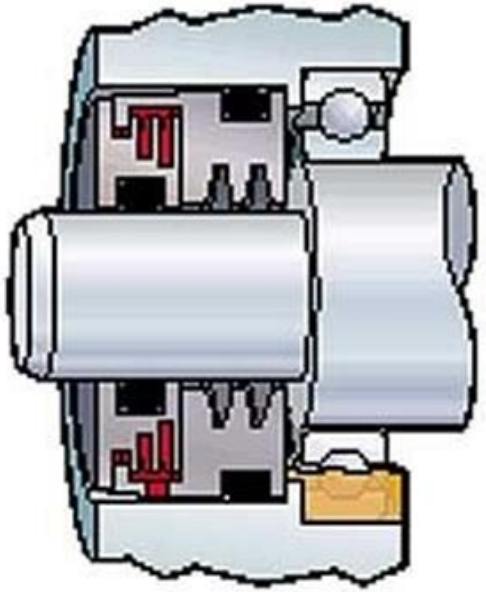
Source: large chemical company in England

Only 7% of measured machines were aligned within tolerance

Lifetime of bearing

- The smaller the offset of the two shafts at the coupling, the longer the expected lifetime of the bearings.

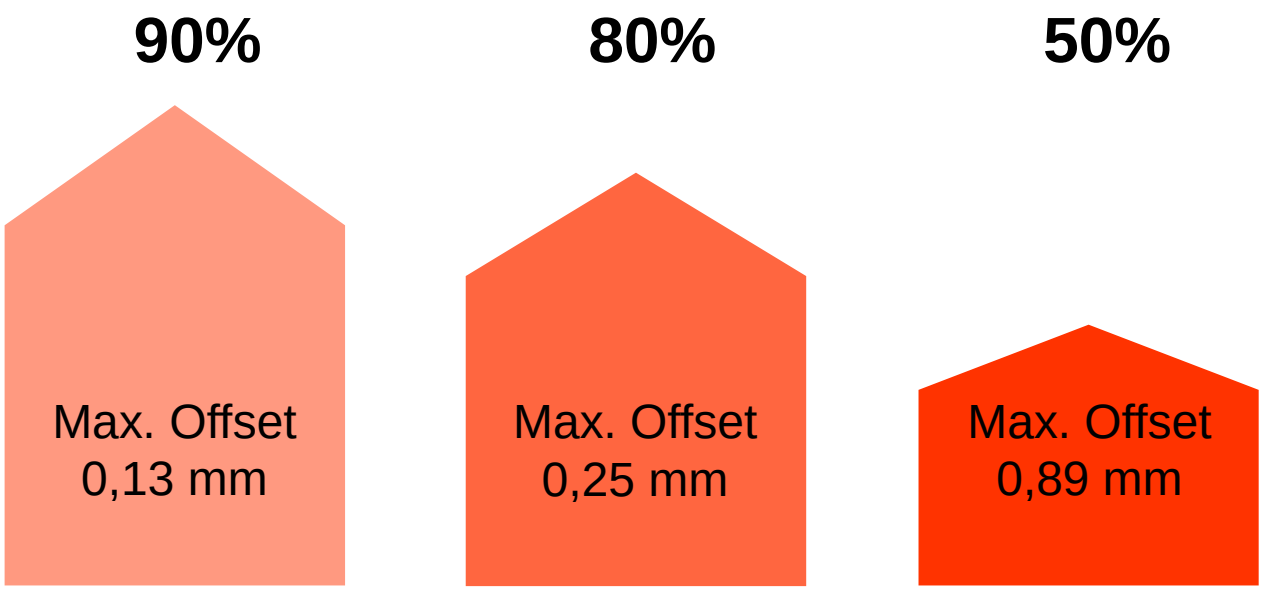




Courtesy of The University of Tennessee

Lifetime of bearings

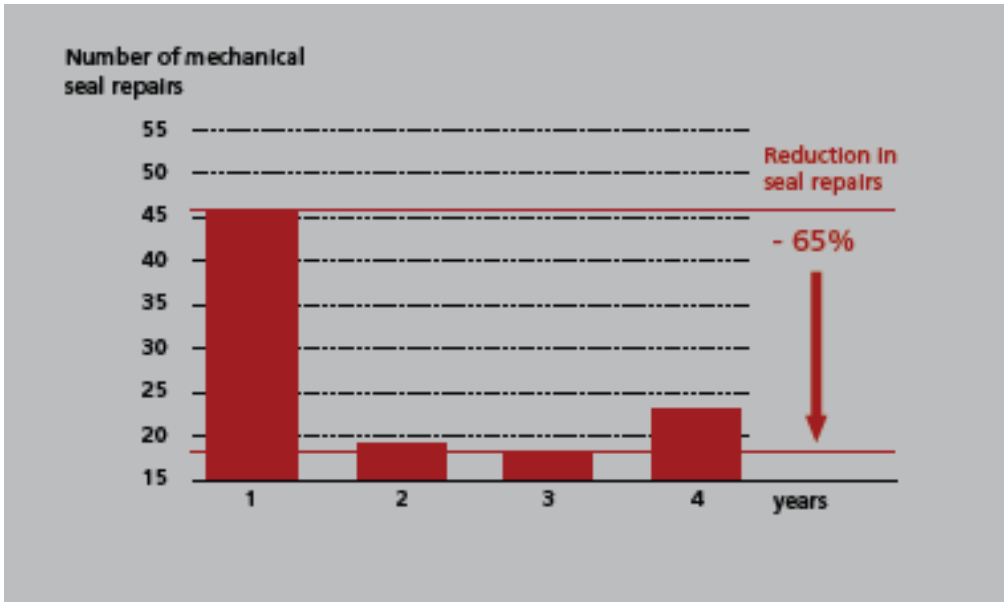
- Maximal percentage of the expected lifetime of a bearing at the example of a gearbox bearing, relative to a perfect aligned system.

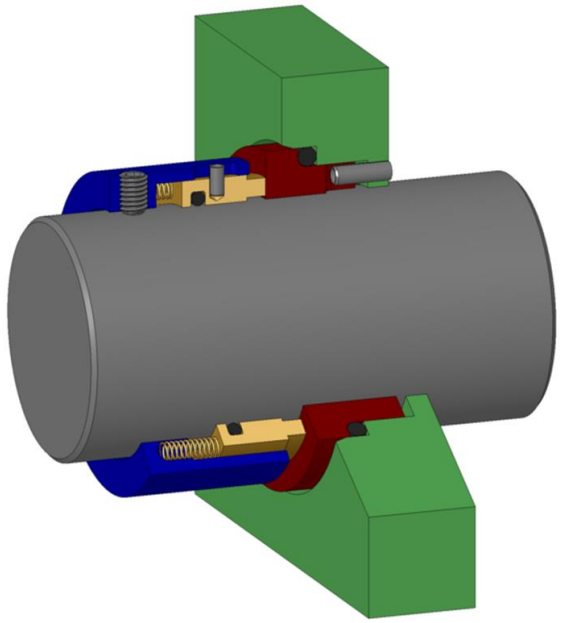


Courtesy of The University of Tennessee

Repair of mechanical seals

- The number of the repair of seals is reduced by 65% after consequent and regular laser optical alignment has been introduced.

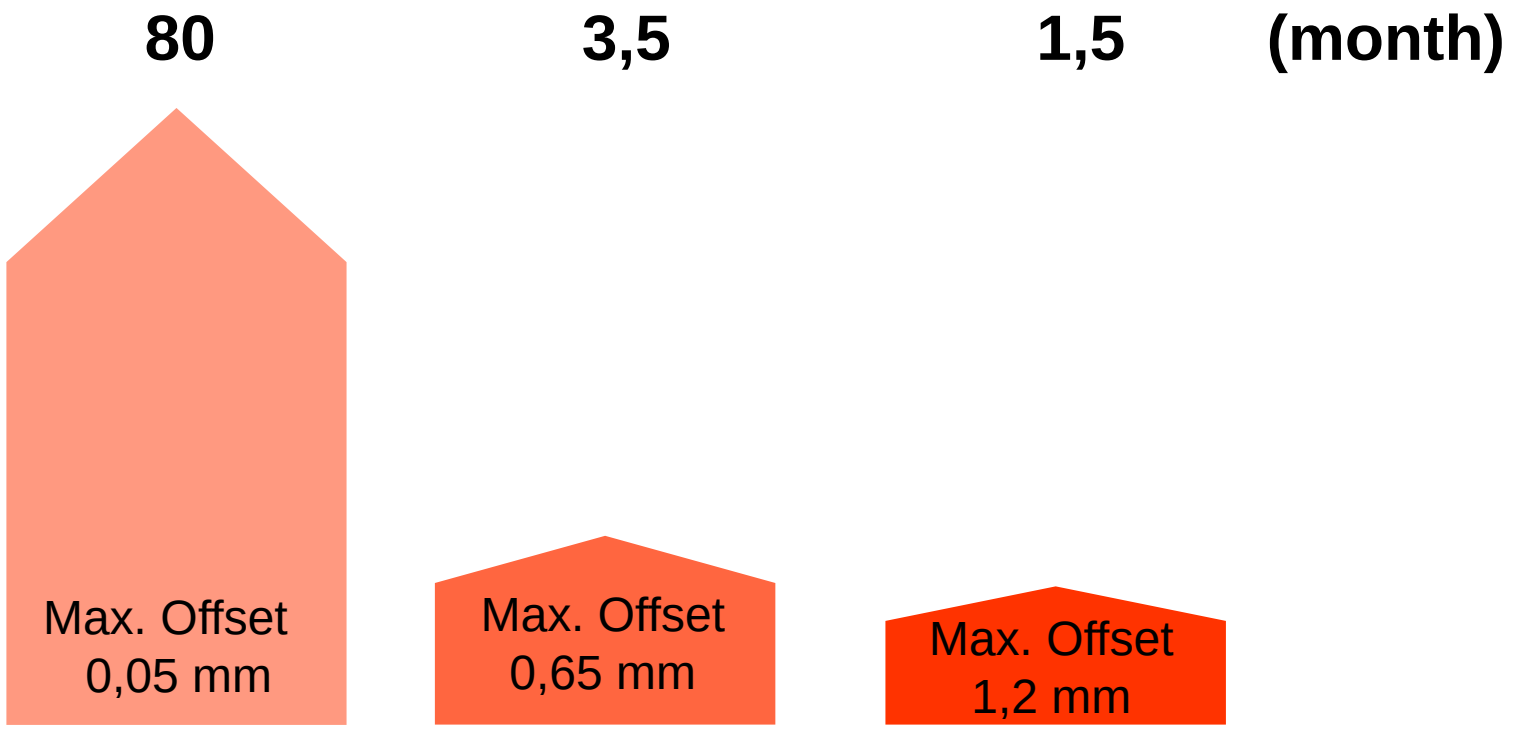




Courtesy of Hoechst AG Gendorf/Germany

Repair of mechanical seals

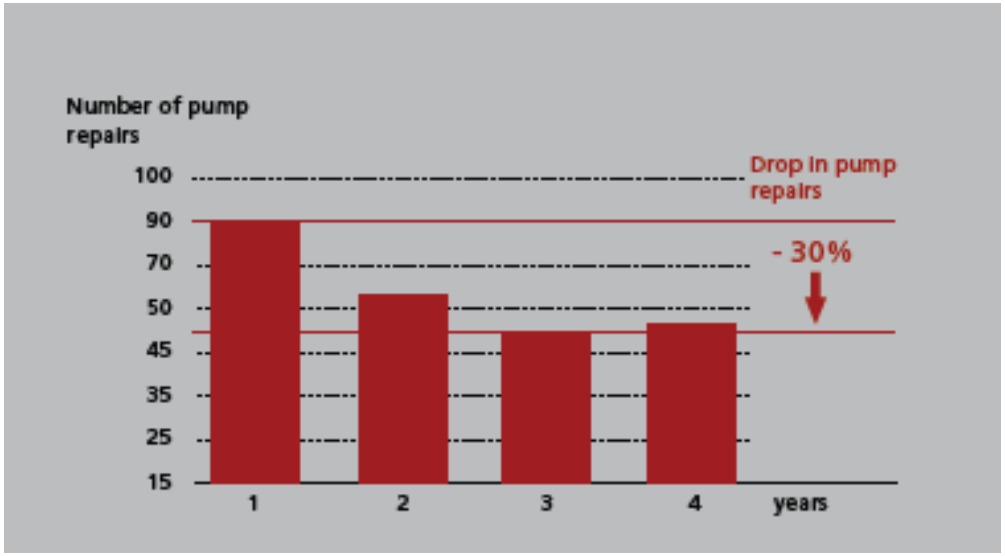
- The lifetime of seals increases significantly with the precise alignment of shafts.



Courtesy from Durametallic plus AES Seals

Repair of pumps

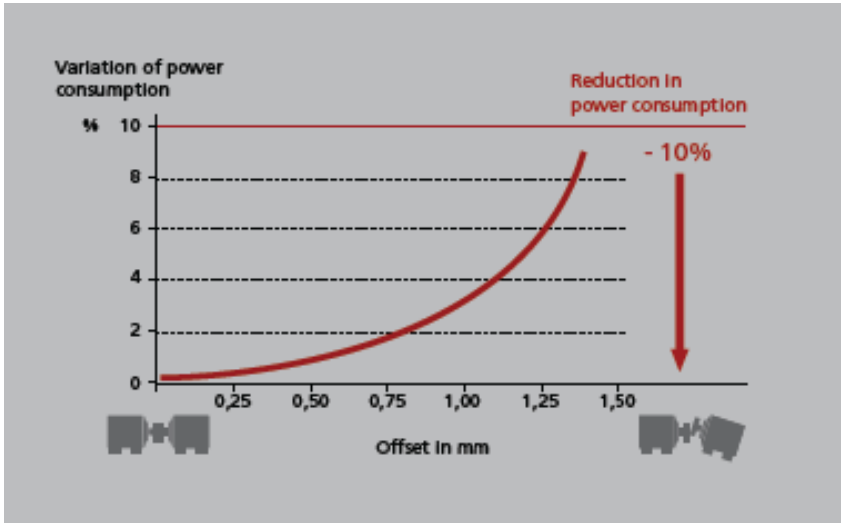
- The number of pump repairs is droping 30% after the consequent and regular introduction of laser optical alignment.



Courtesy of Hoechst AG Gendorf/Germany

Changes in terms of energy consumption

- Significant savings concering the energy consumption can be achieved due to precise shaft alignment
- Perfect alignment reduces restoring forces and reduces the energy consumption up to 10%



Source: UK pump association

Courtesy of an UK major chemical plant

Advantages of precis shaft alignment:

- Optimizing the lifetime of assets
- Cost reduction due to increased lifetime of wear parts (bearings, seals)
- Reduction of longterm maintenance costs
- Optimising reliability of the production process
- Increase the availability of assest
- Reduce the energy costs
- Improve the safety in total
- Contribution to a cleaner environment

Shaft alignment systems

Standard and mobile shaft alignment products

OPTALIGN smart RS5
The power of precision shaft alignment

ROTALIGN Ultra iS
The intelligent alignment platform

ROTALIGN touch
Cloud-enabled laser shaft alignment system

SHAFTALIGN OS3
The efficiency of laser shaft alignment

tab@lign
Laser shaft alignment on tablets ans smartphones

Geometrical measurement systems

Geometrical laser alignment products

LEVALIGN expert
Flatness and level with a spin

LEVALIGN Ultra iS
Flatness, perpendicularity, level, easily done!

PENTALIGN
Perpendicularity and parallelism of axes and planes

PARALIGN

The revolutionary method for roll alignment

CENTRALIGN Ultra expert

Turbine alignment with high accuracy in less time

OPTALIGN smart RS5 Straightness
Straightness measurement in two dimensions

Portable Systems
for machine condition monitoring

Data collectors, vibration analyzers and balancers

VIBXPERT II
The Expert in data collection, vibration analysis and field balancing

VIBXPERT II Balancer
On-the-spot field balancing - simple, fast and accurate!

VIBSCANNER
The clever data collector & vibration analyzer

VIBROTIP
The 5-in-1 data collector for machine condition monitoring

Online Condition Monitoring Systems

VIBGUARD
Advanced Online Condition Monitoring

VIBNODE
Standard Online system for individual aggregates

VIBRONET Signalmaster
Proven Online Monitoring for industrial plants

VIBROWEB XP
Compact Online Diagnostic Monitoring

VIBGUARD portable
Advanced Condition Monitoring on the move

VIBCONNECT RF
Wireless Online Monitoring

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Equipment Alignment for Prolonged Life

Literature:

- Dena: “System Effizienz Pumpen”; http://www.industrie-energieeffizienz.de/fileadmin/InitiativeEnergieEffizienz/referenzprojekte/images/Pumpensysteme_alleFactsheets.pdf
- Herborner Pumpentechnik:”Lebenszykluskosten Erläuterungen und Berechnung”; http://www.herborner-pumpen.de
- Investigations at University Tennesee
- UK pump association
- Investigations at Hoechst/Gendorf in cooperation with PRÜFTECHNIK
- Investigations at ICI (Imperial Chemical Industries) in Great Britain in cooperation with PRÜFTECHNIK
- John Piotrowski: “Shaft Alignment Handbook”; CRC Press; 2007[3]
- PRÜFTECHNIK Alignment Systems Machinery Service Team
- ALIGNMENT newsletter Ausgaben 1/2006 und 3/2009
- Research in Wikipedia

Thank you

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TO MAKE A DIFFERENCE EVERY DAY.

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