



Hennepin County Medical Center



Overcrowding in the Emergency Department

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- Significant overcrowding is present in every ED in the USA with a census over 40,000/year
- It has been associated with significant morbidity and mortality
- Overcrowding has been identified as a significant barrier to timely and efficient assistance to patients with emergent conditions since the 1980s

- Everyone that has an emergency during a demand surge
- Patients without access to routine health care
 - Poor and underinsured
 - Rural areas
 - Very old and very young patients
- Socially marginalized people

- ED crowding is a sentinel indicator of health system functioning
- The root cause is economics
 - Misaligned healthcare economics that pressure hospitals to maintain inefficient high inpatient census levels
 - Systems preference high-margin low risk patients
 - Few efforts address the economically driven root causes of the problem

- Realign health care financing to allow hospitals to keep inpatient capacity below 90%
 - Beyond that point, hospital dynamics inevitably lead to ED overcrowding
- Ensure access to health care beyond EMTALA

More specifically why?

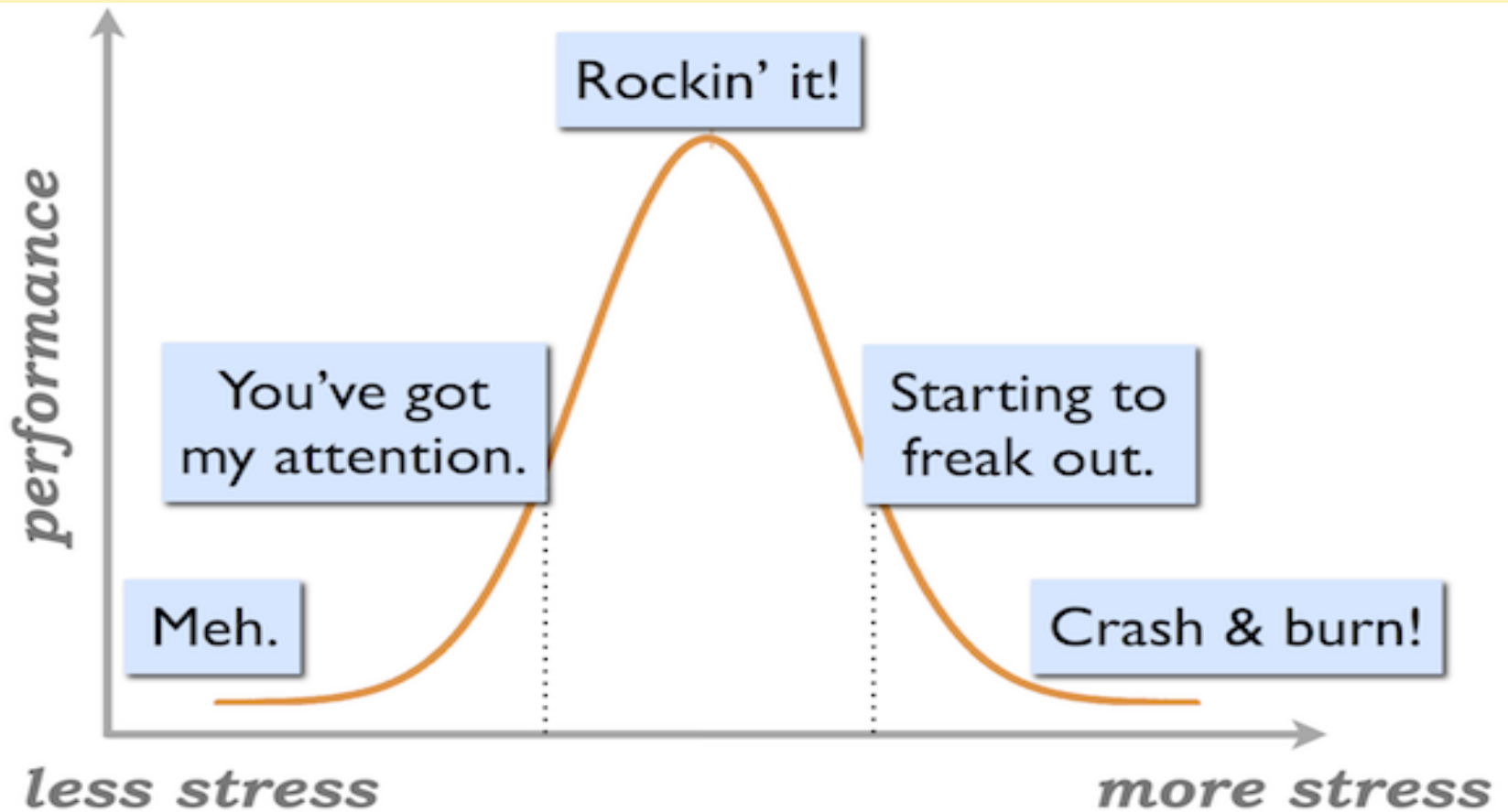
- Incoming volume of patients (input)
- Time to process and treat patients (throughput)
- Volume of patients leaving the ED (output)

- Boarding has been identified as the most significant factor
 - Easy to measure
 - Easy to see its effects of patient care, mortality, morbidity, patient satisfaction, and quality of care
 - Specifically associated with
 - Increased length of stay
 - Increased left without being seen
 - Increased medical errors

- There is no gold standard for measuring it
 - NEDOCs (national emergency department overcrowding score)
 - ED occupancy
 - ED LOS
 - ED volume
 - ED Boarding
 - Emergency Department work index (EDWIN)

- What's the busiest day of the week in the ED?
 - Why?

Stress vs Performance



- A function of activity time, demand and variability
- $\text{Wait Time} + \text{Activity Time} * (\text{Utilization} / (1 - \text{Utilization})) * ((\text{CV}_a + \text{CV}_p) / 2)$
- What this means
 - As utilization approaches 100% the wait time increases dramatically
 - Increasing variability increases expected waiting times
 - CV_a is the time variation in cognitive tasks
 - CV_p is the time variation in execution tasks

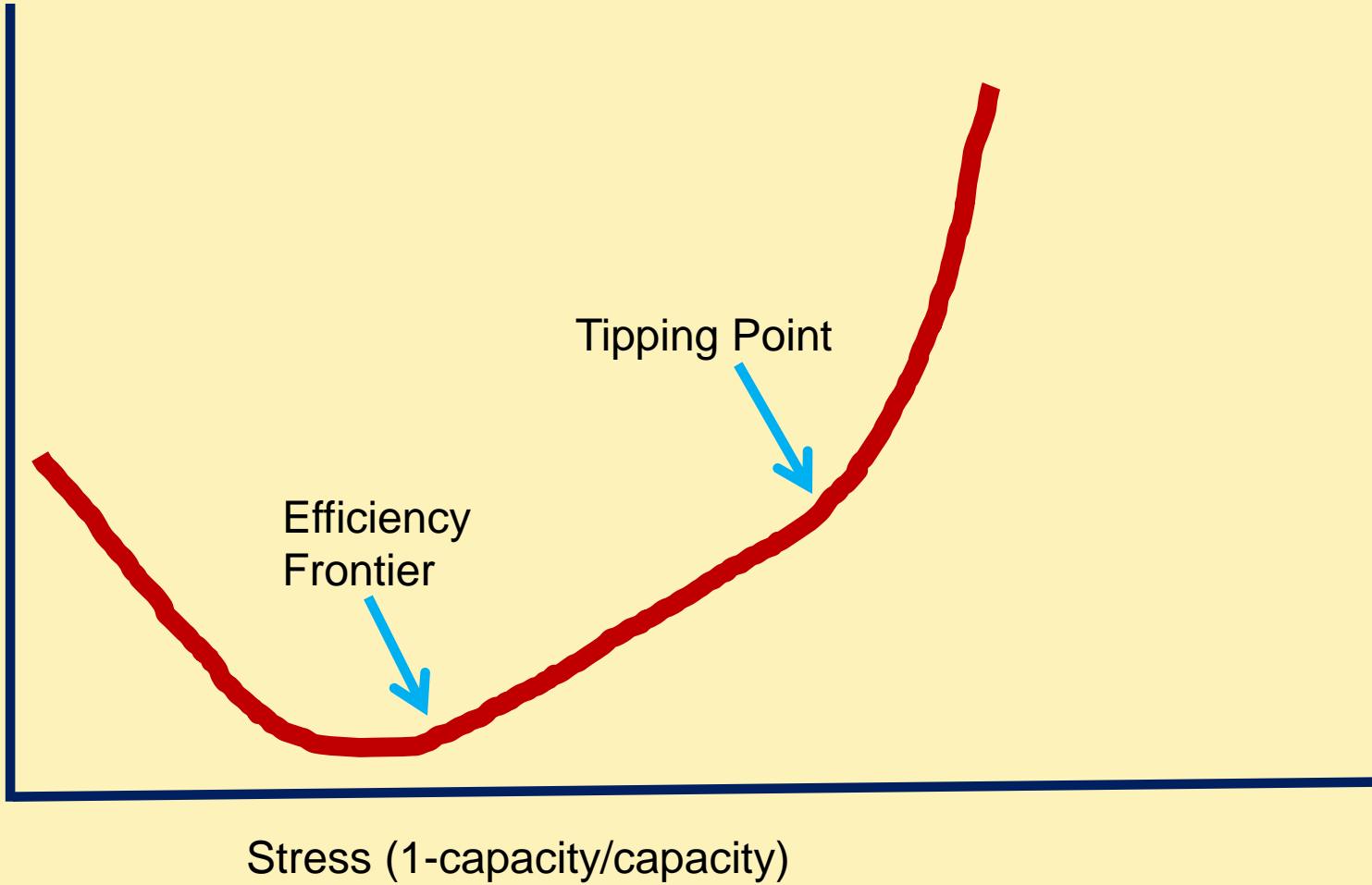
- Capacity at which flow rate is highest
 - In investing it refers to the best ratio of risk to reward
- ED Responsiveness reflects how high this will be
 - $1/\text{wait time}$

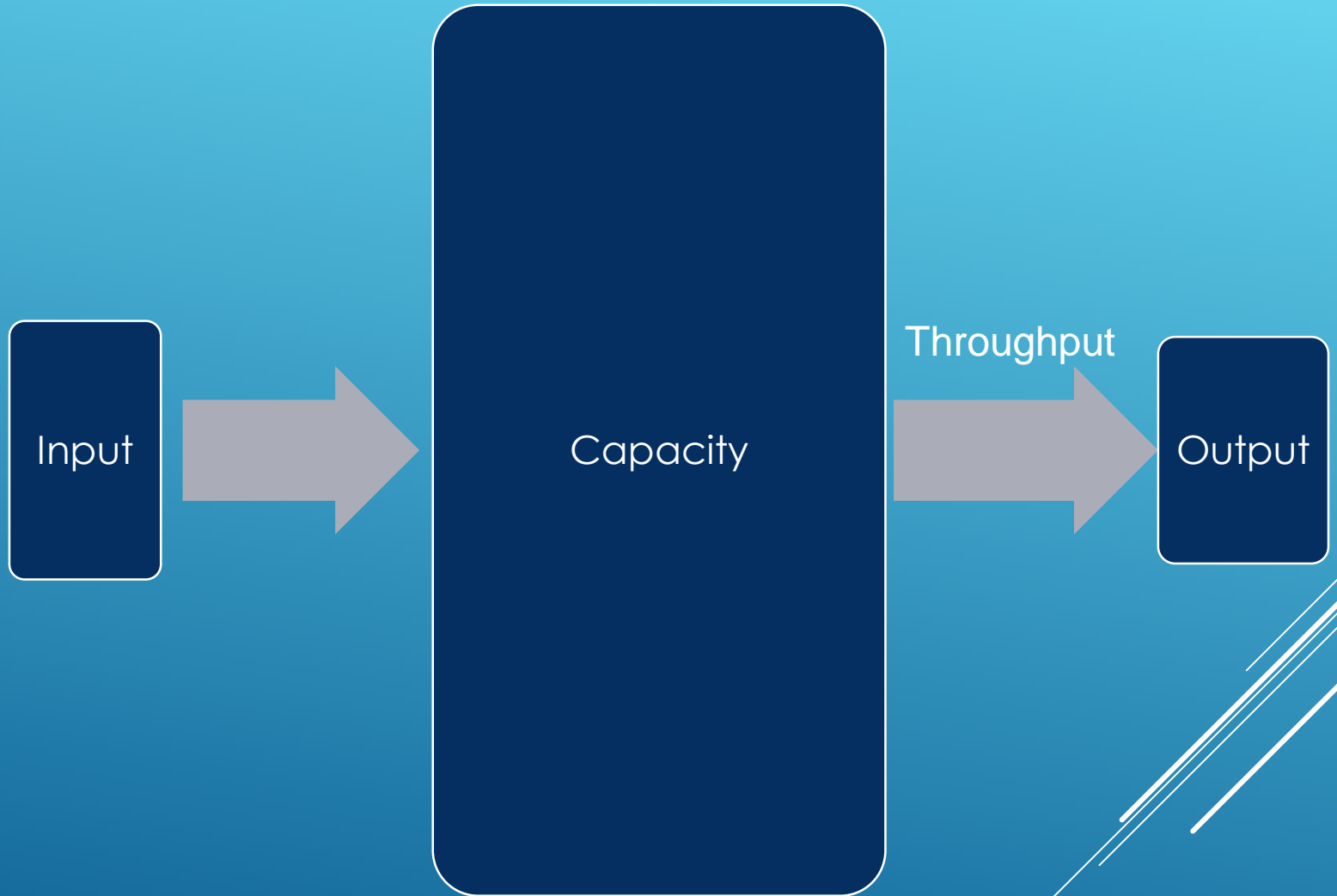



- Increased Capacity without improving efficiency
 - Reduces utilization rates
 - Increases responsiveness
 - Does not improve efficiency frontier, it just makes a new set point
 - Only effective at bottlenecks
 - E.g. increasing beds without decreasing time to inpatient beds does not affect flow rate
 - Adding a physician to ED triage essentially only adds beds without a process improvement

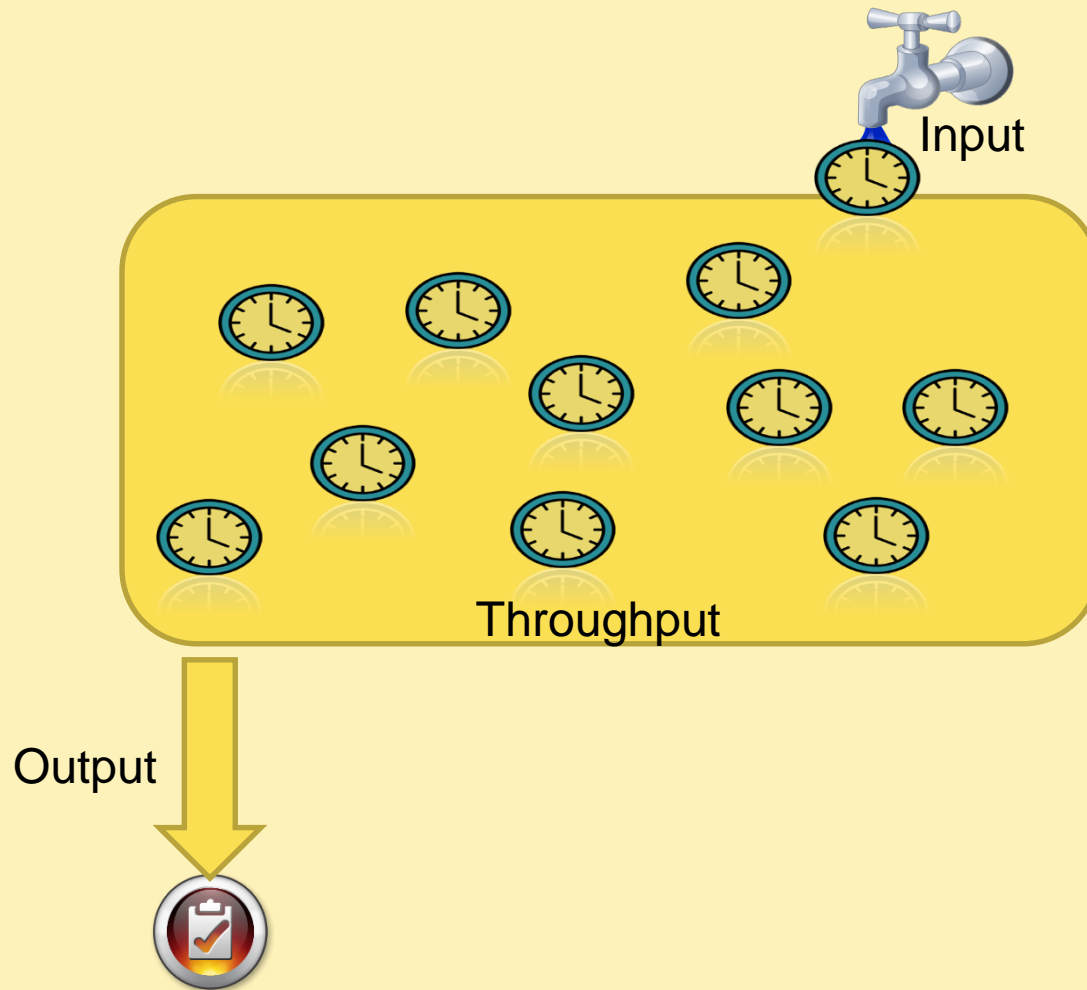


Task
Resolution
Time





 = unresolved task



- Work that needs to be done
 - Unresolved tasks can generate new tasks
 - Some tasks can self terminate
 - This will have an inevitable outcome
 - Resolution of tasks has results dependent on the task

- Some unresolved tasks generate new tasks
 - Sometimes these are value added tasks (we want to keep those generators unresolved)
 - Sometimes these are tasks with dire consequences (we want to resolve these quickly)
 - Sometimes these tasks produce nothing but work (we want to eliminate these tasks)

- Requires variable cognitive effort
 - Cognition (diagnosis)
 - Execution (treatment)

- Some tasks produce something when they are resolved
 - Improved health
 - Income
 - Satisfaction
 - Quality and safety
- Some tasks do not produce anything when they are resolved
- Some tasks can be either based on their stage


- Some resolve without consequence
 - In the case of nonproductive resolution these tasks should go unresolved by our workflow
 - In the case of productive resolution, we need to resolve them prior to self termination to increase productivity
- Some have major consequences
 - Resolution must be a priority for safety independent of their production value

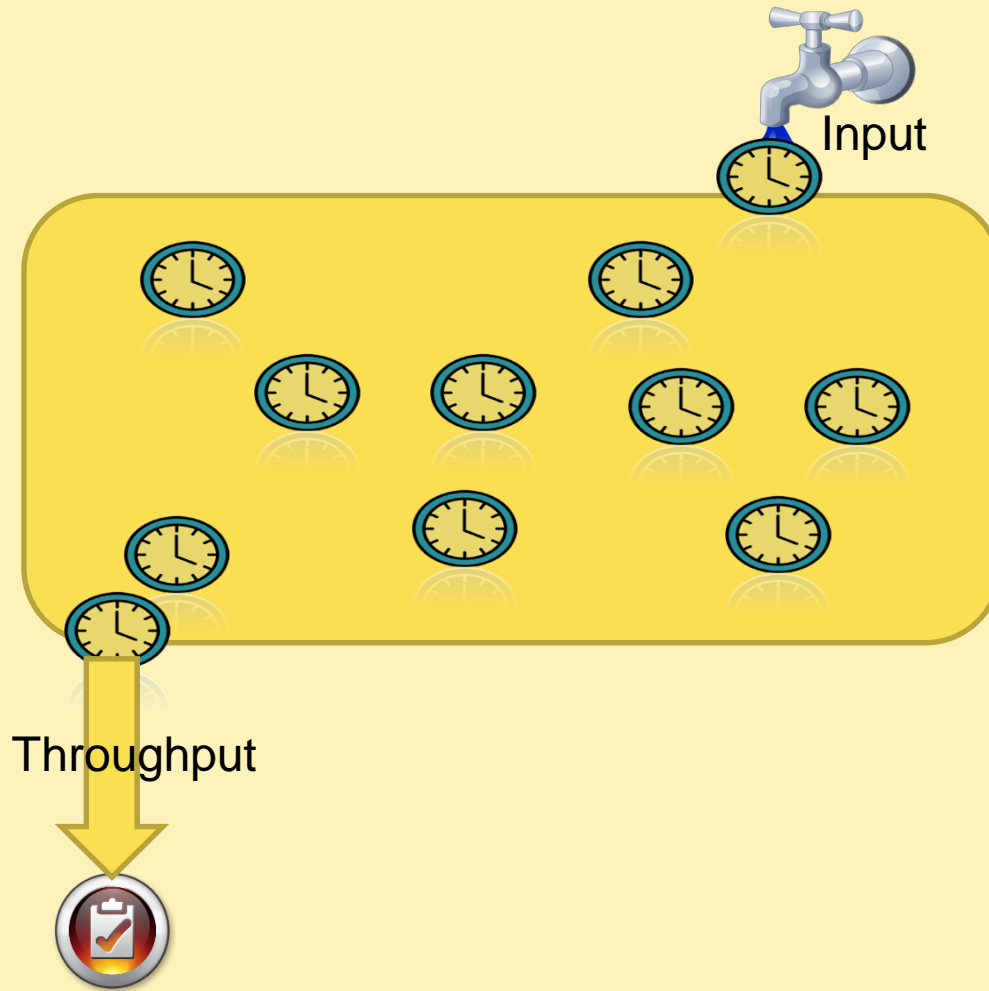
- Moves the efficiency frontier
- Eliminate Waste
- Reduce Variability
 - Provider variability
 - System variability
- Increase Flexibility
 - Demand based staffing
 - Predictive demand models

- Multiple small events can cause a large crisis
- Based on studies of several airline disasters and the USS Vincennes
 - Weick's Theoretical Analysis
 - Based on response to non-novel interruptions in the face of an unanticipated event that temporarily prevents the completion of a usual action
 - Represent tasks in health care modeling

- Resolving a non-novel interruption requires cognitive effort
 - Cognition (diagnosis)
 - Execution (treatment)
- This is variable based on the complexity of the task and increases with the number of interruptions
- Resolving the interruptions is essential to preventing disasters

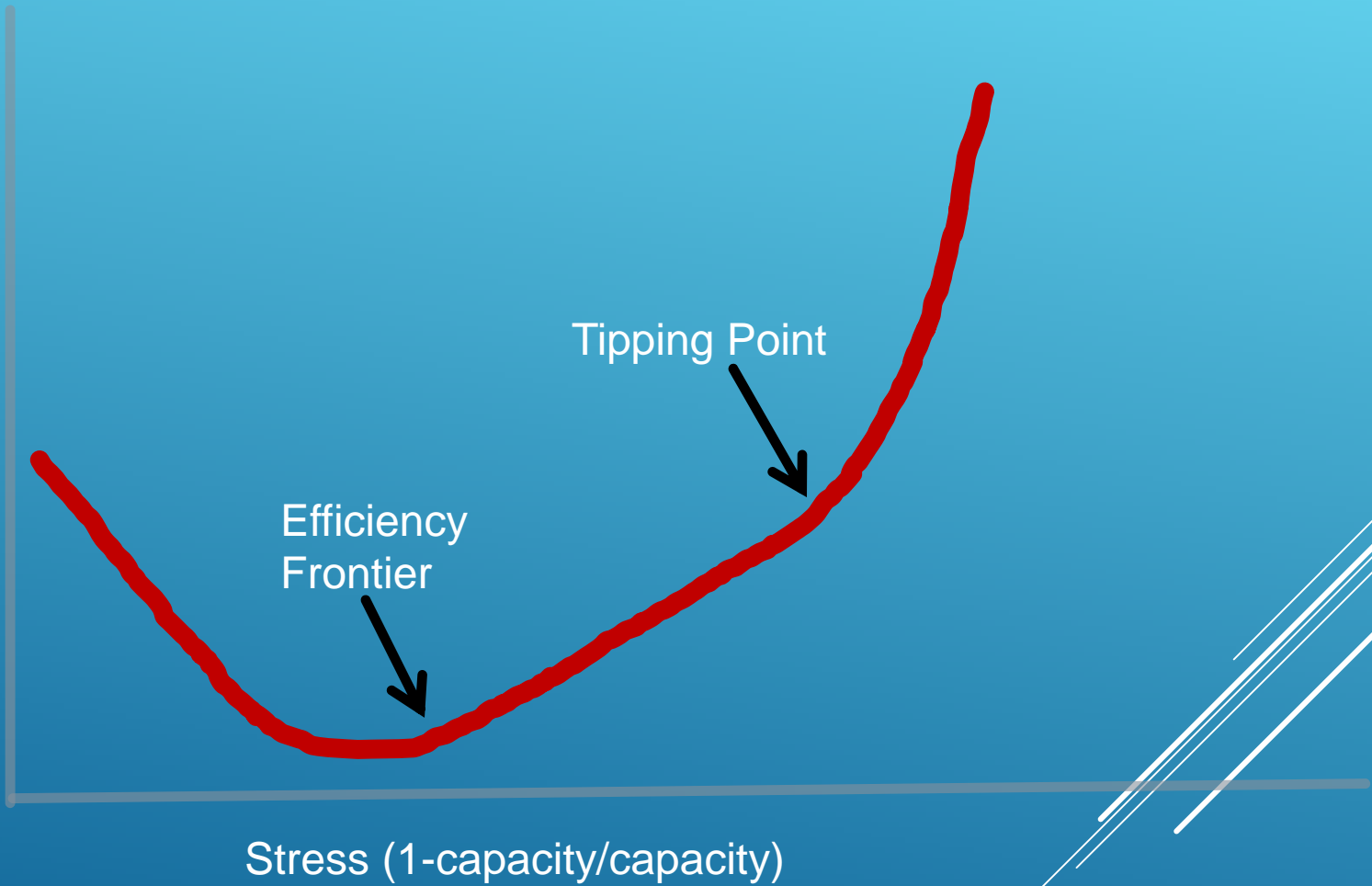
- Non-resolved interruptions accumulate in a feed and stock model, like a bathtub filling up, there is a rate of accumulation and a rate of resolution
- Accumulating interruptions increases the complexity of the existing and future interruptions

 = unresolved task



- Stress is the mismatch of desired resolution time and normal resolution time
- The influence of stress on a system is an inverted U shape effect on resolution time (Yerkes Dodson Law)
 - In low stress, small increases result in increased performance
 - At some point, further increases in stress result in increases in resolution time

Task
Resolution
Time



Efficiency
Frontier

Tipping Point

Stress (1-capacity/capacity)



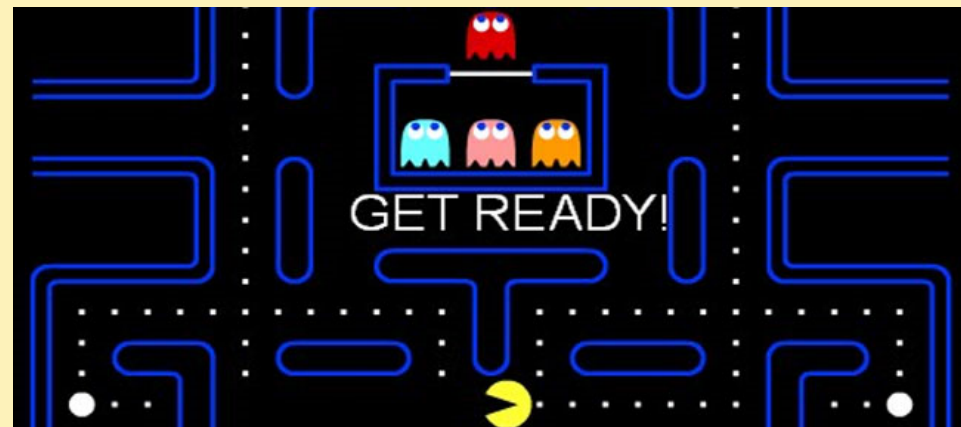
- The point at which further increases in system stress increases task resolution time
- Results in an increase in pending resolutions that can be unassociated with changes in the new task rate
- Eventually will lead to a critical task resolving prior to cognitive execution of a resolution

- A result of quantity rather than novelty
- Increased volumes with normal events can result in disasters
- Pre-Crisis Efficiency can give a false sense of capability
- The ability to recognize an impending crisis decreases as pending interruptions increase

- Confident Adherence to pre-existing routines is generally the most efficient
- Shifting gears to explore novel approaches makes predicting the tipping point difficult and should be reserved for low-capacity times



- Self terminating productive tasks always need to take priority
 - Self terminating non-productive tasks should be ignored
- Tasks that generate productive tasks should be identified



- When its too slow:
 - Raise the stress level
 - Search for productive non self terminating tasks
 - Try novel approaches to improve performance
 - Decrease the capacity



- When the stress is too high
 - Focus on the routine elimination of self terminating tasks
 - Decrease variability
 - Don't try a novel approach
 - Ignore non-productive tasks (this is an active task)
 - Actively delay productive non-self terminating tasks and task generating tasks
 - Increase the capacity

- Efficiency is determined by the stress level
 - Reducing ED crowding requires controlling system stress
 - Stress is much easier to create than to eliminate

- Ensure access to health care
- Decrease variability in elective admission timing
- Increase flexibility of elective admission timing
- Increase access for unscheduled care during surges in input or hospital census