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The Three-Phase Traffic Theory by Dom Einhorn

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Boris Kerner developed a traffic flow theory, known as the three-phase traffic theory, over the course of six years. He finalized the theory in 2002. Unlike classical theories, which are comprised of two basic forms of traffic, congested and free flow; Kernerâ€™s theory involves three distinct phases of traffic: synchronized, free flow and wide moving jam. The oddity in this theory is that Kerner uses â€œwideâ€• to describe length instead of width.

Free Flow Traffic

Traffic that moves freely at or near the stated speed limit is considered free flow. Vehicles may pass other vehicles, exit the roadway or enter the roadway with little to no issues. In Kernerâ€™s theory, free flow traffic correlates positively between the rate of flow and the number of vehicles on the roadway. He supports that free flow ends when the maximum flow corresponds to critical density.

Congested Traffic

Congested traffic occurs when the too many vehicles are using a particular roadway. Congested traffic can be stable and moving or unstable and still, the latter of which is known as a traffic jam. In Kernerâ€™s theory, the speed of a vehicle in congested traffic is lower than the speed of the slowest moving vehicle in free flow traffic.

He supports that small issues may occur on the roadway and vehicles will remain congested, but moving; however, should a larger issue occur, already congested traffic will likely be halted altogether, causing a jam. However, Kerner breaks congested traffic into two forms; synchronized and wide moving jam.

Kernerâ€™s Synchronized Flow

Kerner describes synchronized flow as the point at which vehicles are accelerating to meet free flow traffic. In his diagrams and charts, synchronized traffic is fixed in the form of a bottleneck, which is considered a downstream front.

Kernerâ€™s Wide Moving Jam

When vehicles move up the highway through bottlenecks like that of Kernerâ€™s synchronized flow and maintain mean velocity while achieving this, Kerner considers this a wide moving jam. As of this writing, it is not known why Kerner chose the term â€œwideâ€• for this phase of his theory, as his theory actually refers to the length of the traffic congestion rather than the width of the transitional head or tail zones.

Kernerâ€™s Fundamental Hypothesis

Kernerâ€™s hypothesis for his three-phase traffic theory is based on homogeneous synchronized traffic flow. What this means is that he based the hypothesis on identical drivers, driving identical vehicles that are all evenly spaced and moving at identical speeds. His hypothesis states that this can potentially occur at any two-dimensional point on the flow-density plane. The states of free flow and synchronized flow on multi-lane roads are separated, both by a flow rate gap and a speed gap at particular densities. The free flow speed will always be higher than that of synchronized flow.

In addition, drivers are considered to make arbitrary choices that determine the space gap between their vehicle and the one before them. Therefore, the driver chooses different gaps in space at various times and will not continually use only one specific gap.

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