

# *Haworth's Law*

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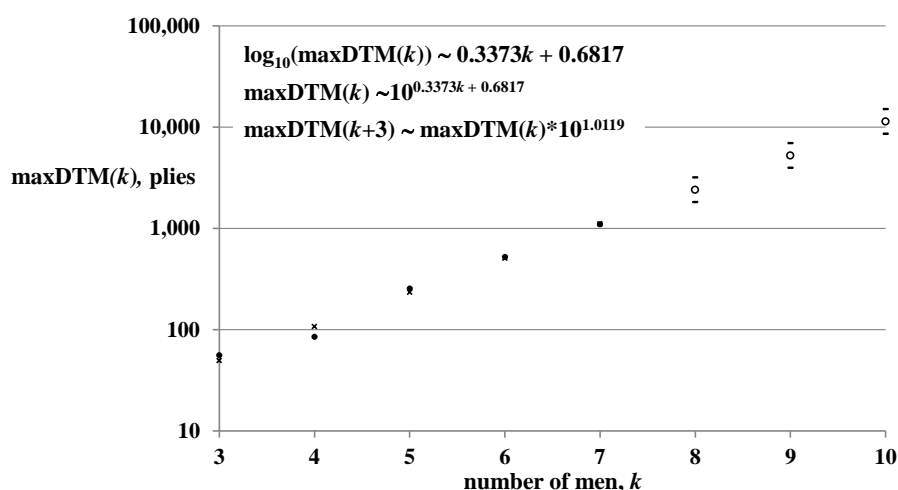
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## HAWORTH'S LAW

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The latest ‘Depth to Mate’ results from the Lomonosov team (Zakharov, 2013) find a maxDTM 7-man wtm win in KQPKRBN of 1,097 plies, i.e., of 549 winner’s moves. They therefore add one data point to an already suggestive trend of  $\log(\text{maxDTM})$  against  $k$ , the number of men on the board. Figure 1 is a plot of the data (Haworth, 2013) showing the actuals for 3- to 7-man chess, the best least-squares linear fit<sup>2</sup> to these points, and the extrapolation of that ‘fit’ to 10-man chess with  $2\sigma$ , 97% probability, confidence levels.



**Figure 1.** The maxDTM( $k$ ) trend: actuals, best linear fit, predictions and  $2\sigma$  confidence intervals.

Here are some of the conjectures which may be made, using the following notation:

$E \equiv WB$ , an endgame with White force  $W$  and Black force  $B$ ,

$Em \equiv WmBm$ , endgame  $E$  with man  $m$  added to both sides,

$\text{maxDTM}(E) \equiv$  the maximum DTM in plies of the White wins in  $E$  (‘0’ if there are no wins), and

$\text{maxDTM}(k) \equiv \max\{\text{maxDTM}(E) \mid E \text{ is a } k\text{-man endgame}\}$

- 1) if  $k \geq 3$ ,  $\text{maxDTM}(k+1) > \text{maxDTM}(k)$ ,
- 2) if  $k \geq 3$ , a maxDTM  $k$ -man position  $p_k$  may be modified to a position  $p_{k+1}$  with greater DTM depth: the side which does not have the move may often be imagined to have just captured a man,
- 3) if  $k \geq 3$ , there is a  $k$ -man endgame  $E$  and man  $m$  such that  $\text{maxDTM}(Em) \geq \text{maxDTM}(E)$ ,
- 4) the linear trend above will continue for some time, i.e., ‘Three more men: maxDTM times ten!’”

With Moore’s Law in mind, the last conjecture was dubbed *Haworth’s Law*, as it were, *en passant* by a visiting Thomine Stolberg-Rohr WFM. It is certainly a prediction like Moore’s Law rather than a provable, physical law. However, it is not a self-fulfilling prophecy as many argue Moore’s Law is. The rules of the game have determined those deep wins and losses already. For 8/9/10-man chess, the model gives a 50% probability of decisive results in  $2400^+ / 5220^+ / 11340^+$  plies and  $2\sigma$ -predictions of results in  $1810^+ / 3940^+ / 8570^+$  plies. It gives a 90% probability of an 8m result in  $2000^+$  plies and an 80% probability of a 10m result in  $10000^+$  plies. The model at least challenges us to consider why this might be and how long the trend will continue.

## References

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Zakharov, V. (2013). Private communication of ‘MVL’ Lomonosov 7-man DTM EGT statistics.

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<sup>2</sup> The best-fit quadratic polynomial reduces the ‘linear’ residual error by only 6% and gives even higher predictions for the 8/9/10-man maxDTM. The best cubic and quartic fits clearly give overfitted models which are not credible.