

TOYO TIRE TALK

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Technical Service Department Japan
 Technical tips and information that may
 allow you to better serve your customers.



We would appreciate your input, please contact us.
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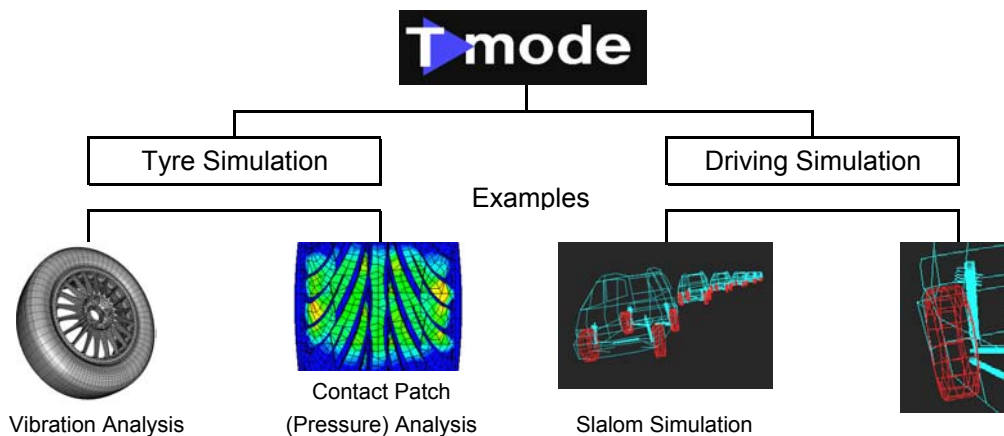
29th October, 2002

Subject : The Process of T-mode in Tire Development

1. Introduction.

T-mode is an excellent and advanced simulation tool which has become part of Toyo's strategic development. The outline of this technology has already been introduced, however we shall summarise the main features of this new and exciting development.

T-mode consists of two simulations - 'Tire Simulation' and 'Driving Simulation'.



Tire Simulation is a developed version of the previous DSOC-2. This now consists of nine variations of simulation - Contact Surface, Friction Energy, Rolling Resistance, Cornering Force, Strain, Tyre Design Optimization, Hydroplaning, Tread Pattern Analysis and Vibration Analysis. The basic simulation software uses FEM (Finite Element Method) and Dytran (for Hydroplaning analysis). The software was adopted earlier by the tyre industry, but Toyo has made many improvements to customize this giving Toyo a considerable advantage. Many of the Toyo designs have been developed using these tools.

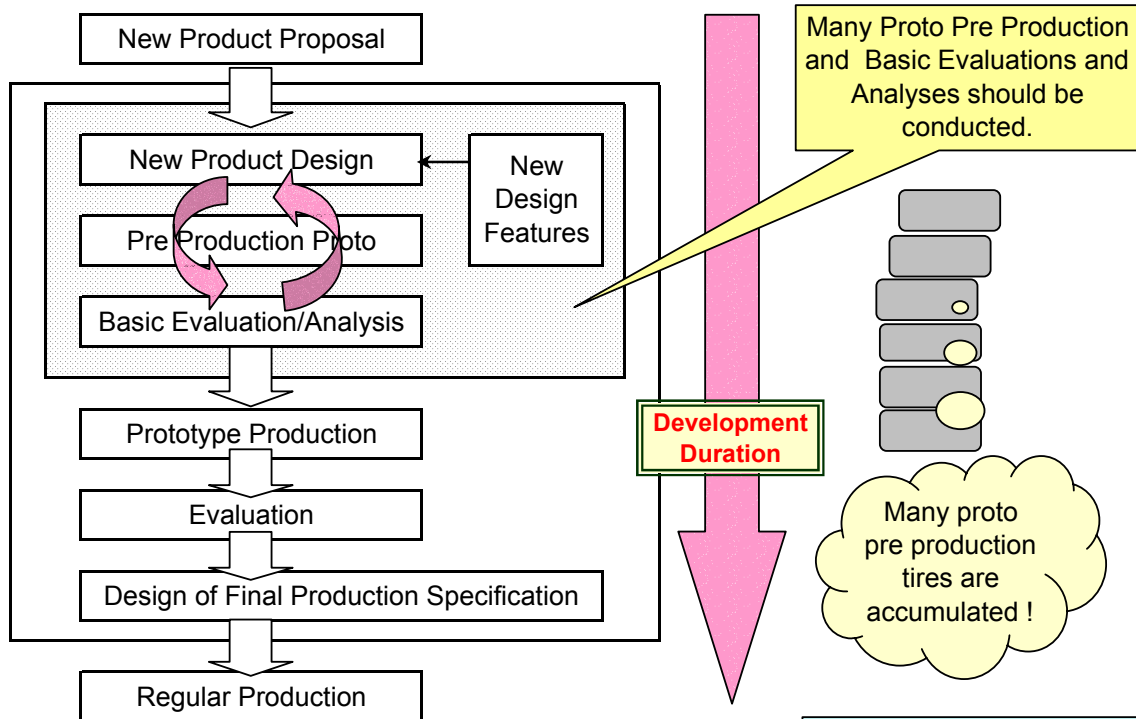
Driving Simulation adopts ADAMS (Automatic Dynamic Analysis Mechanical System), which is commercially available software generally used in the airplane and car industry. This software has been customized and improved by TOYO since it was utilized in 1991. Driving Simulation now allows for six types of simulation - Lane Change, Emergency Avoidance, Slalom, High-Speed Straight Driving, Ride Comfort (across projection) and Braking Performance.

In 2000 **Driving Simulation** was successfully combined with **Tire Simulation** to provide a practicable tool for tyre development. This is a first for the Japanese tyre industry. T-mode has been adopted in the several new products (Px TPT, Trampio Vimode etc.) for the export market.

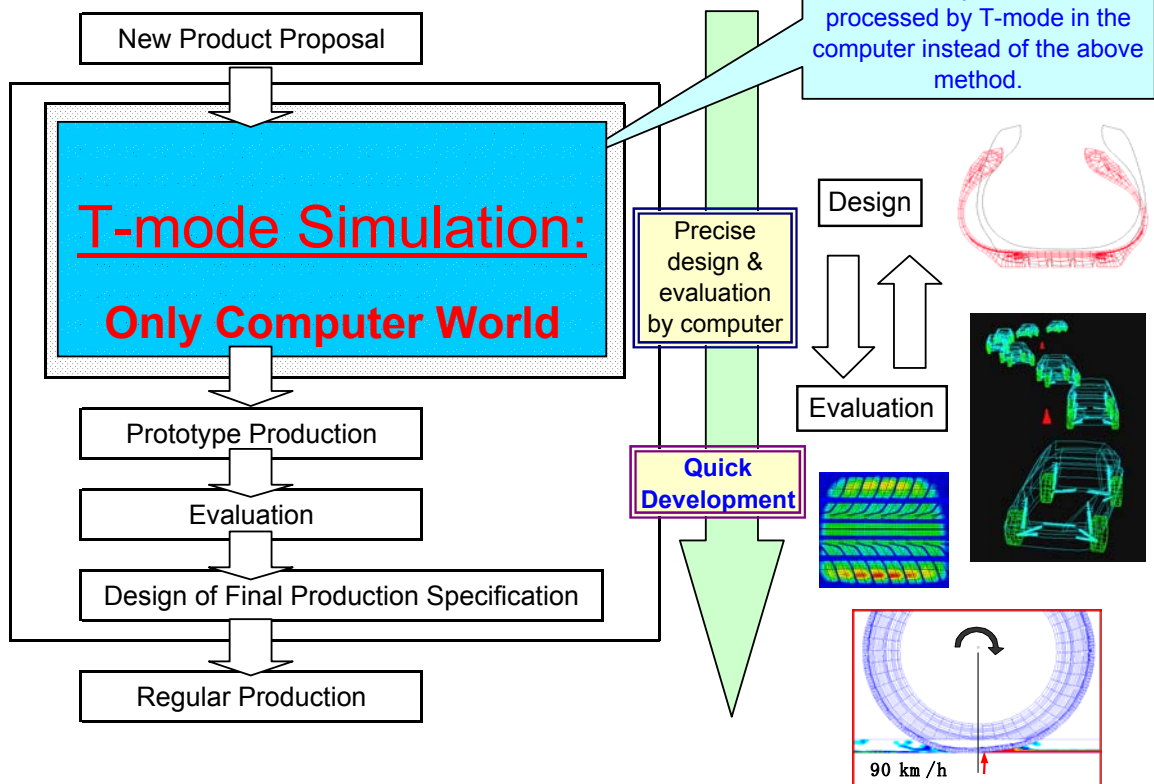
We will now introduce the role of T-mode in the tyre development process.

2. Development Process using T-mode.

Without T-mode



With T-mode



3. Actual Effects of T-mode in the Development Process.

The effects actually obtained during the tyre development stage utilizing T-mode are shown below.

For example:

Development Process, Number of Pre Proto & Proto Production, Required Period and Result.

Item		Without T-mode	With T-mode
Pre Proto Production & Evaluation in general	Process	Grooved tyres for test are initially required.	Tyre modelling and evaluation in computer
	Number	1-3 times	1-2 times
	Period	1-3 months	1 or 2 weeks to 2months
	Result	Trial and error is required.	Tyre with profile, dimension and material which may be difficult for trial production, can be realised easily in the modelling and evaluation.
Proving Evaluation on actual vehicle	Process	Proving Evaluation is conducted without pre-simulation.	Proving Evaluation is done after confirming tyre performance by simulation in some degree.
	Number	3 times	2 times
	Period	5 months	4 months
	Result	Test condition is limited.	Test conditions which are hard to set in actual evaluations can be done in the simulation.
Optimized Foot Print	Process	Proto production is made by experience or previous production results.	Proto production is done by eliminating some unusable tire profiles.
	Number	1-3 times	1 time only
	Period	1-3 months	1-2 months
	Result	Trial and error is required in the trial production.	Final tire profile may almost be created by 1 trial production.
Optimized Pattern Pitch in Noise Simulation	Process	Grooved tyres and noise measurement is required again and again.	Noise simulation can be easily done by changing the pattern pitch condition.
	Number	1-2 times	1 time
	Period	1-2 months	1-1.5 months
	Result	Trial and error is required.	Final pattern pitch may be decided by simulation.





Remark : The Number and Period indicated is for reference only.

T-mode enables study and development of new tyres of a higher level than by the previous development method. The reduction in development time by utilizing T-mode is evident.

4. Comparison of the Tyre Design method with Competitors.

All Japanese tyre manufacturers use their own simulation technologies. There may be some difficulty distinguishing between them, which may make it difficult to explain to customers Toyo's superiority over the competitor's methods.

The following table compares the Toyo method to the competitors with the aim of helping your understanding of the superiority of the Toyo system.

Manufacturer	Pet Name	Release	Feature	Software
	T-mode	2000	Tyre Simulation	(FEM)
			Driving Simulation	(ADAMS)
	AQ DONUTS	1997	Tyre Simulation	(FEM)
	DRS 2	2001	Tyre Simulation	(FEM)
			Environment Simulation (=Driving Simulation)	(FEM)
	DNA	1999	Tyre Simulation	(FEM)

Driving Simulation has been developed (published) by Toyo and Dunlop only.

Dunlop adopts FEM in the driving simulation which takes considerable more time in the simulation model calculation and in computer calculation time compared with ADAMS.

Toyo adopts ADAMS in the driving simulation which each tire designer can use easily, and on a daily basis.

We can say definitely T-mode has an advantage over the competitors.