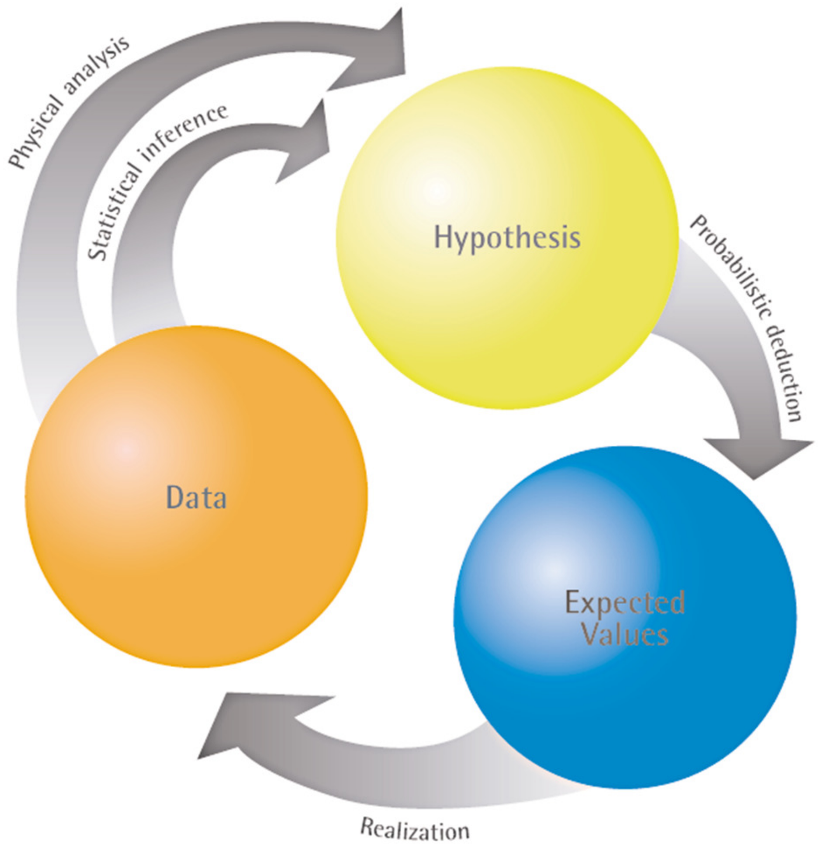

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Contenuti /*Current topics*

- Componenti elettronici - Affidabilità - Condizioni di riferimento per i tassi di guasto e modelli per la loro conversione in funzione delle sollecitazioni
  Electronic components - Reliability - Reference conditions for failure rates and stress models for conversion
- Banche dati di affidabilità – Modelli generici per la predizione di affidabilità di componenti elettronici
  Reliability data handbook – Universal model for reliability prediction of electronics components, PCBs and equipment

Obiettivi / *Main results*

- Calcolo del tasso di guasto e valutazione MTBF / *Failure rate and MTBF*
- Report di affidabilità / *Reliability reporting activity*

Riferimenti / *Main sources*

- IEC TR 62380
- CEI EN 61709
- MIL HDBK 217 F - TELCORDIA SR 332

Modelli/ *Models*

"Reliability is the probability that an item can perform its intended function for a specified interval under stated conditions" [MIL-HDBK-338B].

Reliability prediction models (MIL-HDBK-217, TELCORDIA, IEC 61709, IEC TR 62380) offer standard equations that allow you to calculate the failure rate of components by gathering information regarding component data and parameters. These parameters often include environment, temperature, quality, and stress. These parameters are used to establish ***pi factors***, which are the variables used in the reliability prediction equations.
Once the individual failure rates for components are established, in a series model a simple summation of the component failure rates provides the failure rate for the higher level assemblies and system.

The component failure rate under operating conditions is calculated as follows:

$$\lambda = \lambda_{ref} \times \pi_U \times \pi_I \times \pi_T \times \pi_E \times \pi_S \times \pi_{ES}$$

Impiego / *Role*

The reliability prediction may be used as a guide to improvement by showing the highest contribution to failure

The predicted will also help evaluate the significance of reported failure to determine whether the number of failures Is commensurate with the number of components used in the system

Maintenance strategy planners can make use of the relative probability of a failure's location, based on predictions, to minimize downtime. Reliability predictions are also used to evaluate the probabilities of failure events described in a failure modes, effects and criticality analysis (FMECAS).

Avvertenze / *Limitations*

The first limitation is that the failure rate models are point estimates which are based on available data. Some extrapolation during model development is possible, but the inherently empirical nature of the models can be severely restrictive.

A reliability prediction should never be assumed to represent the expected field reliability as measured by the user (i.e., Mean-Time-Between-Maintenance, Mean-Time-Between-Removal, etc.). This does not negate its value as a reliability engineering tool; note that none of the applications discussed above requires the predicted reliability to match the field measurement.

A basic limitation of reliability prediction is its dependence on correct application by the user. Those who correctly apply the models and use the information in a conscientious reliability program will find the prediction a useful tool. Those who view the prediction only as a number which must exceed a specified value can usually find a way to achieve their goal without any impact on the system.

MIL HDBK 217

- DEPARTMENT OF DEFENSE WASHINGTON DC 20301 RELIABILITY PREDICTION OF ELECTRONIC EQUIPMENT - *This standardization handbook was developed by the Department of Defense with the assistance of the military departments, federal agencies, and industry*

- establish and maintain consistent and uniform methods for estimating the inherent reliability (i.e., the reliability of a mature design) of military electronic systems. It provides a common basis for prediction for military electronic systems and equipment

- establishes a common basis for comparing and evaluating reliability predictions of related or competitive designs

- is a tool to increase the reliability of the equipment being designed

Metodi / *Methods*

- Part Count
- Part Stress

Part Count

- Requires less information, generally part quantities, quality level, and the application environment. This method is applicable during the early design phase and during proposal formulation. In general, the Parts Count Method will usually result in a more conservative estimate (i.e. higher failure rate) of system reliability than the Parts Stress Method.

Part Stress

- The Part Stress Analysis Method requires a greater amount of detailed information and is applicable during the later design phase when actual hardware and circuit are being designed

Data should be obtained from the following sources in the given order of preference:

1) user data
2) manufacturer data
3) handbook data

Esempio / *Application*

- Part Count su modulo trasmissione 3G modello MILHDBK 217
- Part Stress su modulo trasmissione 3G modello MILHDBK 217
- Modello Telcordia SR 332

3G Module - Value	Result 217 PS	Result 217 PC	Result Telcordia
Failure Rate, Predicted	5,674812	11,842148	2,341089
MTBF, Predicted	176217,306	84444,14209	427151,6611
Reliability, Predicted	0,999433	0,998816	0,999766
Availability	1	1	1
MTTR	0	0	0

Environment

GU Reference Environment	*Severity*	*Standard database*
Mean Temperature	30°C÷40°C	
Stationary vibration, sinusoidal	2 ÷ 9 Hz : ≤ 3mm 9 ÷200 Hz : ≤ 10 m s^{-2}	MIL HDBK 217
Temperature rate of change	> 0,5°C/min	MIL HDBK 217
Non-stationary vibration including shock	≤ 250 m s^{-2}	MIL HDBK 217
Classes	3K7 3K7L 3M4 3M5	CEI EN 60721-3-3

The environment may be described in terms of several types of parameters.
IEC 60721-3-3 describes the environment in terms of

- climatic conditions,
- special climatic conditions,
- biological conditions,
- chemically active substances,
- mechanically active substances,
- mechanical conditions (both static and dynamic).

Stress

Component Category	***Design Stress***	***IEC 61709 Stress***
Resistor	20% ÷ 25% Power Ratio	50 % of rated voltage at 40 °C
Capacitor (excluding electrolytic)	10% Voltage Ratio	50 % of rated voltage at 40 °C
Capacitor (Al electrolytic)	40% Voltage Ratio Corrective factors	80 % of rated voltage at 40 °C
Semiconductor	70% Voltage Ratio	50% Voltage Ratio
Switching	50% Voltage Ratio	50% Voltage Ratio
Zener,regulator	70% Voltage Ratio	70% Voltage Ratio
IC Linear	30% Power Ratio/T.rise ≤ 20°C	70% Power Ratio/T.rise ≤ 20°C
IC Logic all	self-heating	rated stress self-heating
IC Logic (CPU,FPGA)	self-heating	rated stress self-heating
Inductors	20 % of rated power at 40 °C	50 % of rated power at 40 °C
Quartz	rated stress	rated stress
Connectors	rated stress	50 % of rated current
Relays	rated stress	1 cycle/hour

Profilo di missione / *Mission profile*

Example 1 - Telecoms

There is only one annual working phase to consider for a permanent working.

Table is given for a permanent working. Values for "ground; stationary; non weather protected"(Ground; fixed for Mil-HDBK-217F) are given for the French climate, but other climates can be calculated.

Environment types	Equipment types	(tae)I °C	(tac)i °C	Π i	Π ON	Π OFF	N1 cycles/year	DT °C/cycle
Ground; benign: (GB)	Switching	20	30	1	1	0	365	0
Ground; benign: (GB)	Transmitting	20	40	1	1	0	365	0
Ground; fixed: (GF)	Transmitting and access	11	31	1	1	0	365	8

Example 2 - Automotive

MTBF di missione / *Mission profile MTBF*

Apparati Monitorati	MTBF [h] GM@40°C		
	Extended	Service	Hazard
	Duty cycle 100%	Duty cycle 67%	
BOX	893.209	1.641.653	1.963.898
CPU			
CPU-main	132.750	269.439	335.265
CPU-slave	138.627	268.935	334.485
SERIAL	257.363	943.196	1.180.210
MVB extend	5.455.999		
MVB main	106.007		
PROFIBUS	319.855	477.395	477.395
WDIO			
WD	168.881	268.248	268.248
IONV	149.460		
RELE'	334.393		
RXDIG			
RXDIG	254.319	450.016	
GPS/GSM	54.633		
Antenna SSC			
Antenna SSC	361.944	542.916	
Antenna SSC ext	361.944	542.916	
ALIM	70.000	105.000	105.000
MMI	150.000	225.000	225.000
Sistema	**8.854**	**22.198**	**36.963**

Riassumendo: Obiettivi delle predizioni di affidabilità

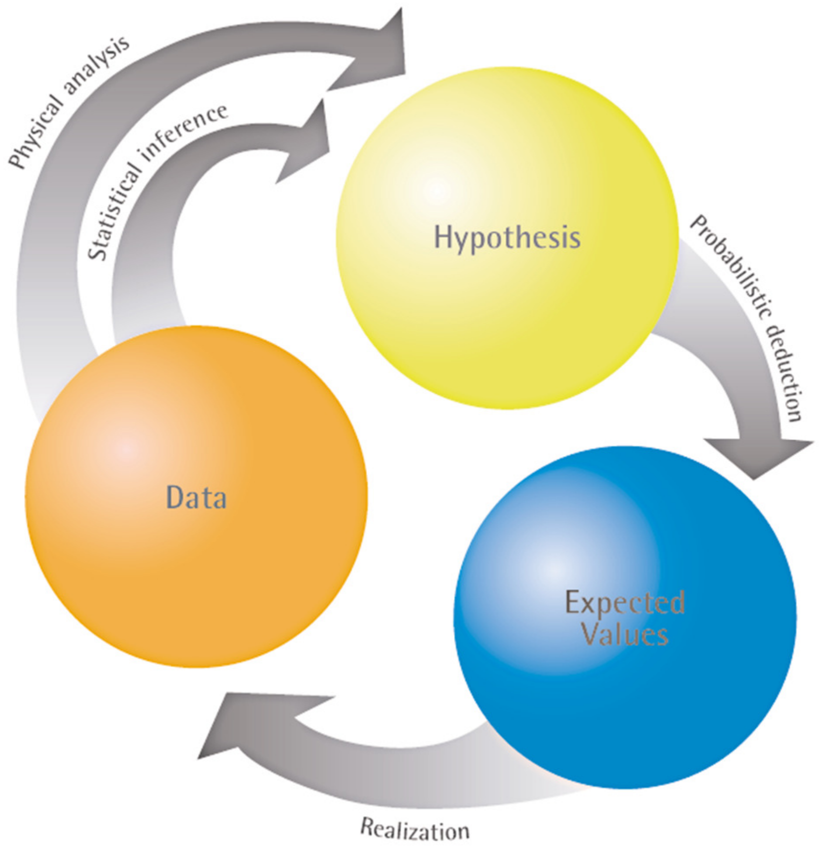
- Nella fase di progetto permettono l'eliminazione di criticità esistenti indirizzando:

  la ripartizione dell'affidabilità tra le parti del sistema (allocazione)
  l'ottimizzazione delle condizioni di impiego (stress)
  l'ottimizzazione del progetto termico (temperatura)
  il confronto di soluzioni alternative e varianti di progetto

- Costituiscono gli elementi base per ricavare la probabilità degli eventi di guasto descritti nelle tecniche FMECA

- In una fase successiva di analisi di sistema le previsioni di affidabilità sono elemento fondamentale nell'analisi di disponibilità , manutenibilità e nel dimensionamento delle scorte (logistica)

- Infine, le previsioni di affidabilità costituiscono un riferimento che permette di monitorare le verifiche di affidabilità (prove e dimostrazioni) ed evidenziare eventuali comportamenti anomali al fine di porvi rimedio (analisi dei guasti).


Physical analysis
Statistical inference
Hypothesis
Probabilistic deduction
Data
Expected Values
Realization