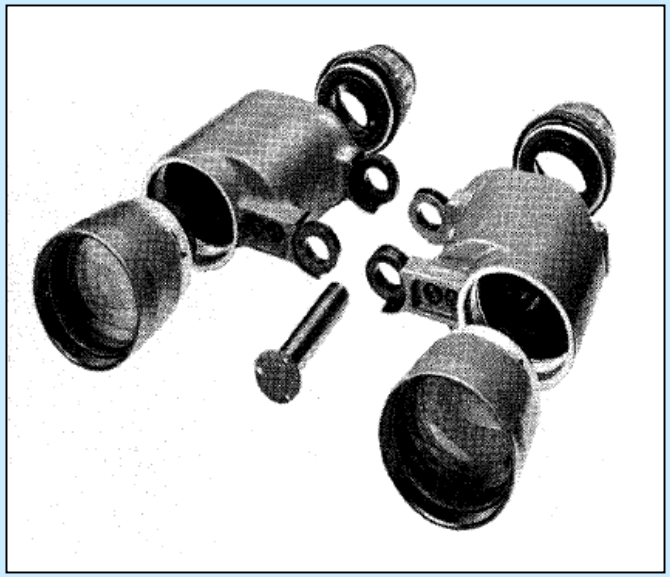
Presentation on “Production Engineering and Implementation of a Modular Military Binocular”



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Key Words

Binocular	双眼鏡
T14/T14E1/M19	双眼鏡のモデル名
Modularity	モジュール方式
Monte Carlo Analysis	モンテカルロ分析
Collimation	視準/平行
Dipvergence	垂直平行性
Divergence	水平平行性
Production Engineering	生産技術 / 製造
Stereoscopic	立体鏡
Asymmetric	不均整
Housing	筐体
Eyepiece	接眼レンズ
Objective	対物レンズ

Basic Summary

- Binocular: Key instrument for military personnel
- WWII-model issues (size, weight, reliability, maintenance)
- Post-WWII: US Army authorizes work on a new binocular
  - First effort: T14
  - Evolution: T14 → T14E1 → M19

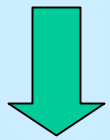
Emphasis on modular design

- Successful with respect to stated objectives
- Mass-production of M19 and related issues

Key Players

Farrand Optical Company and Frankford Arsenal

(Development of T14 → M19)

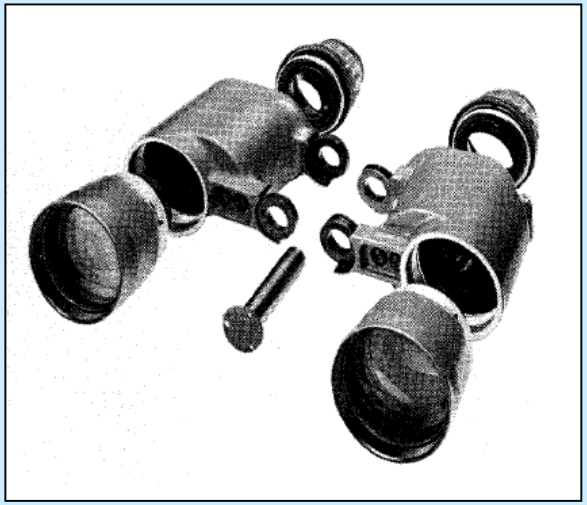


Bell & Howell Company

(Mass Production of M19)

Modularity

M19



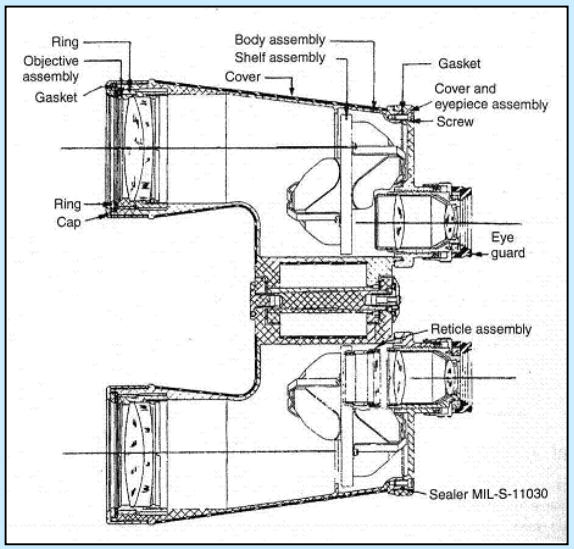
- 5 non-maintainable modules:

  (Eyepiece, objective, hinge pin, left and right housings)

- Only 2 special tools required for assembly/disassembly

- Issues described in Slide 3
- 250 separate parts
- 100 special tools required for assembly/disassembly

WWII Era



Performance Requirements

CHARACTERISTIC	UNITS	SPECIFICATION RANGE
Collimation	minutes of arc	
Dipvergence		+/- 15
Divergence		20 +/- 20
Resolution	seconds of arc	6 maximum
Image Tilt	minutes of arc	30 maximum
Parallax	mm	0.127 maximum
Eyepiece Focus	diopters	+/- 4

Collimation – most difficult specification parameter to achieve

Production Engineering Concept

- Production flow: Fabrication → Assembly → Machining
  - No alignment or adjustment after assembly maintains consistency with modular design.
- Approach:
  - Pre-focused/collimated modules
  - Module machining after assembly/sealing
  - Significant effort on tooling/machining using optical alignment to meet specifications
  - Simple optical testing to qualify components
  - Studies to ensure specification compliance and improve quality

Production Engineering Issues

- Housing Module
  - New adhesive delivered by US Army
  - Fixturing required to maintain position of prisms
- Objective Module
  - Telephoto air-spaced triplet
  - Critical dimensions = tight tolerances
  - Mounting surfaces defined last after assembly/sealing
- Eyepiece Module
  - Axial movement for focus with minimal “wander” leads to spring preload solution

Summary

- M19 provided US armed forces with a truly modular military binocular that addressed the issues of previous models.
- The M19 offered reduced size and weight and rapid field-maintenance.
- Numerous issues encountered/solved with regards to production engineering of M19.