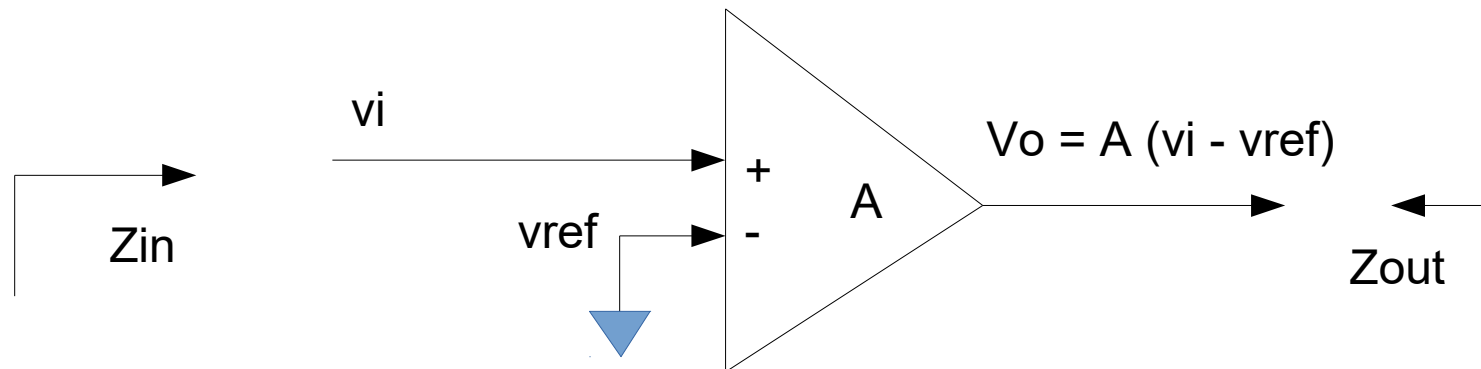


El Op-Amp y Bob Widlar

El amplificador operacional

Si pudiéramos construir un amplificador con las propiedades:

a) muy alta impedancia de entrada (no cargaría, no influiría en las etapas anteriores).

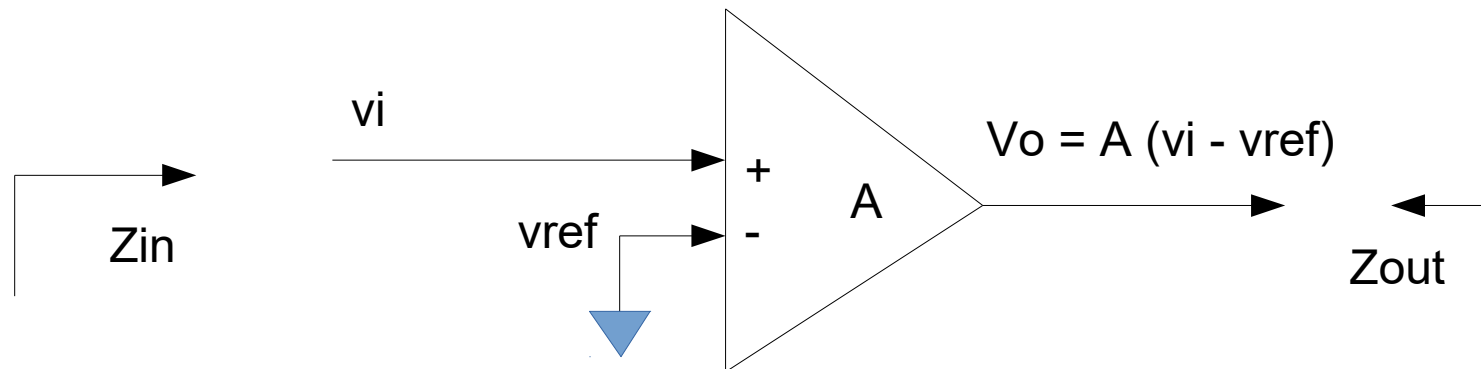


El amplificador operacional

Si pudiéramos construir un amplificador con las propiedades:

a) muy alta impedancia de entrada (no cargaría, no influiría en las etapas anteriores).

b) muy baja impedancia de salida (no sería cargado, influido, por etapas posteriores)



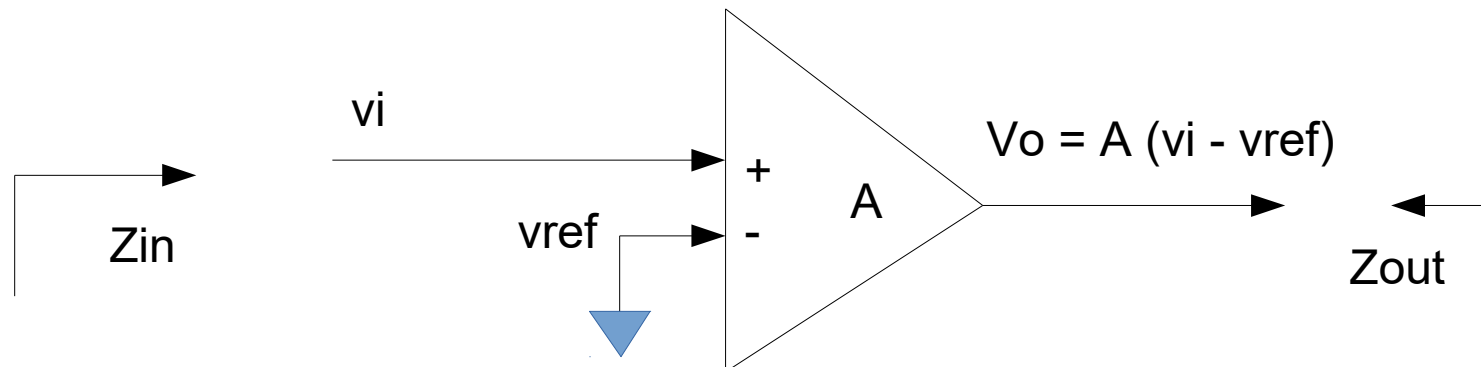
El amplificador operacional

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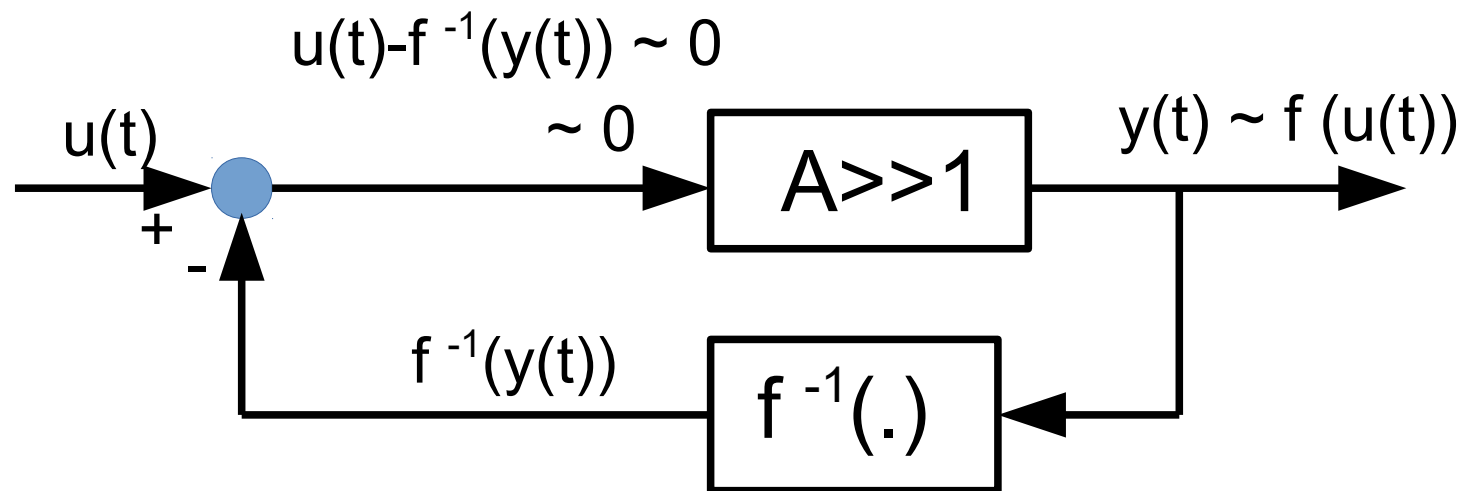
c) muy alta ganancia



Podríamos, por ejemplo, sintetizar funciones algebraicas y realizar operaciones:

Supongamos una función $f(\cdot)$ monótona creciente, invertible.

Supongamos que podemos sintetizar su inversa $f^{-1}(\cdot)$



Entonces $\rightarrow y(t) \sim f(u(t)) !!!$

Estado tecnológico.

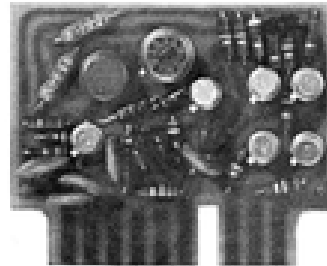
Válvulas de vacío (patente 1941)

Dispositivo comercial 1953.



Transistores

Dispositivo P45, 1961



Integrados

P.ej.: μ A741 en 1968



Nace la industria de los Circuitos Integrados

- William Shockley. co-inventor del transistor (1951), funda la compañía “*Shockley Semiconductor*” (1956) en Mountain View, para estar cerca de la casa de la suegra. Sería pronto “Silicon Valley”. Contrata jóvenes doctores en física como parte de su equipo. Hay serias dificultades de ambiente de trabajo.
- Robert Noyce, Gordon Moore y el resto de los “8 traidores” abandonan Shockley y fundan “*Fairchild Semiconductor*” (1957) que se convierte en líder de la microelectrónica rápidamente.
- Robert Noyce co-inventa el primer circuito integrado (1959).
- Cerca de 65 empresas de los siguientes 20 años estarán “emparentadas” con Fairchild.
- Posteriormente Noyce y Moore abandonan Fairchild y fundan Intel (1968)



Bob Widlar (1937-1991)

- Pionero en la concepción, diseño y construcción de circuitos integrados analógicos lineales.
- Fairchild Semiconductor (1963-1965)
 μ A702 - Primer amplificador operacional monolítico (1964), y μ A 709 (ganancia 70.000).
- National Semiconductor (1966-1970)
LM100 - Primer regulador lineal de voltaje
LM101 – Op-amp, mayor ganancia, menor consumo, protección contra cortocircuito.
- Numerosas patentes, p.ej.: fuente de corriente Widlar, referencia de voltaje Widlar bandgap, etapa de salida Widlar.
- Para 1970 más de la mitad de los CI's del mundo fueron diseñados por Widlar y Talbert.
- 1970 vende sus acciones en U\$ 1: y se retira a "no trabajar" a Puerto Vallarta (México) a los 33 años.



Bob Widlar (1937-1991)

- Patente de fuente de corriente para CI's (1967)

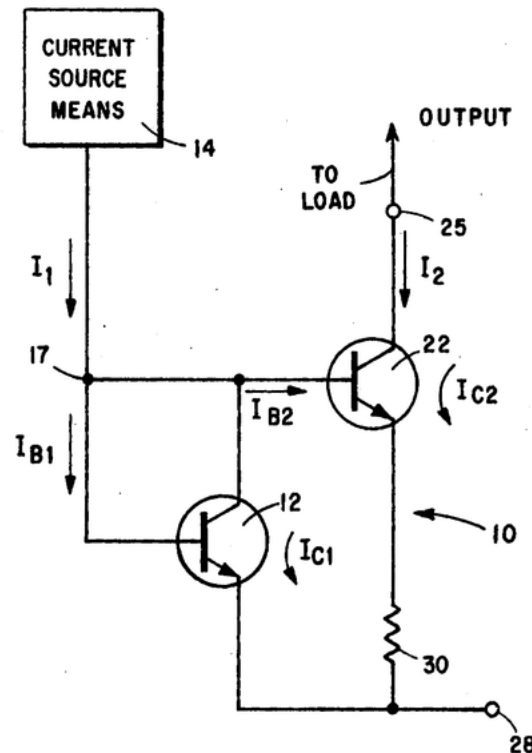
May 16, 1967

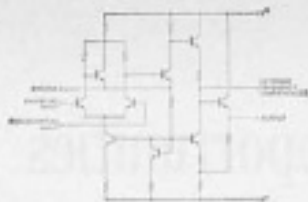
R. J. WIDLAR

3,320,439

LOW-VALUE CURRENT SOURCE FOR INTEGRATED CIRCUITS

Filed May 26, 1965

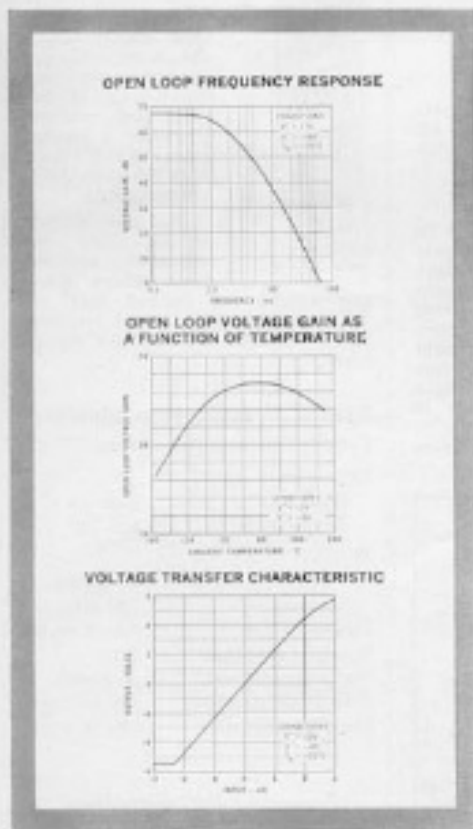




NOW-A COMPLETELY INTEGRATED OPERATIONAL AMPLIFIER

New Silicon Planar μA702 features low offset, high gain

- Low input offset voltage – 2mV
- Low Thermal Drift – 5μV/°C
- High voltage gain – 2800
- Large Output Swing – ±5.5V
- Operation over a wide range of supply voltages



Built into a single chip of silicon using Fairchild's Planar Epitaxial process, the new μA702 is a complete operational amplifier useful from d-c through 10 mc. It was specifically designed for applications requiring a feedback amplifier, such as miniaturized analog computers and precision instrumentation. It is mounted in 8-lead TO-5 or Fairchild's CERPAK flat package (10 leads with 8 active). The μA702 features the same high reliability as Fairchild Micrologic. Prices (TO-5 package): 1-24, \$50; 25-99, \$40; 100-999, \$34. For complete specifications, write for data sheet.

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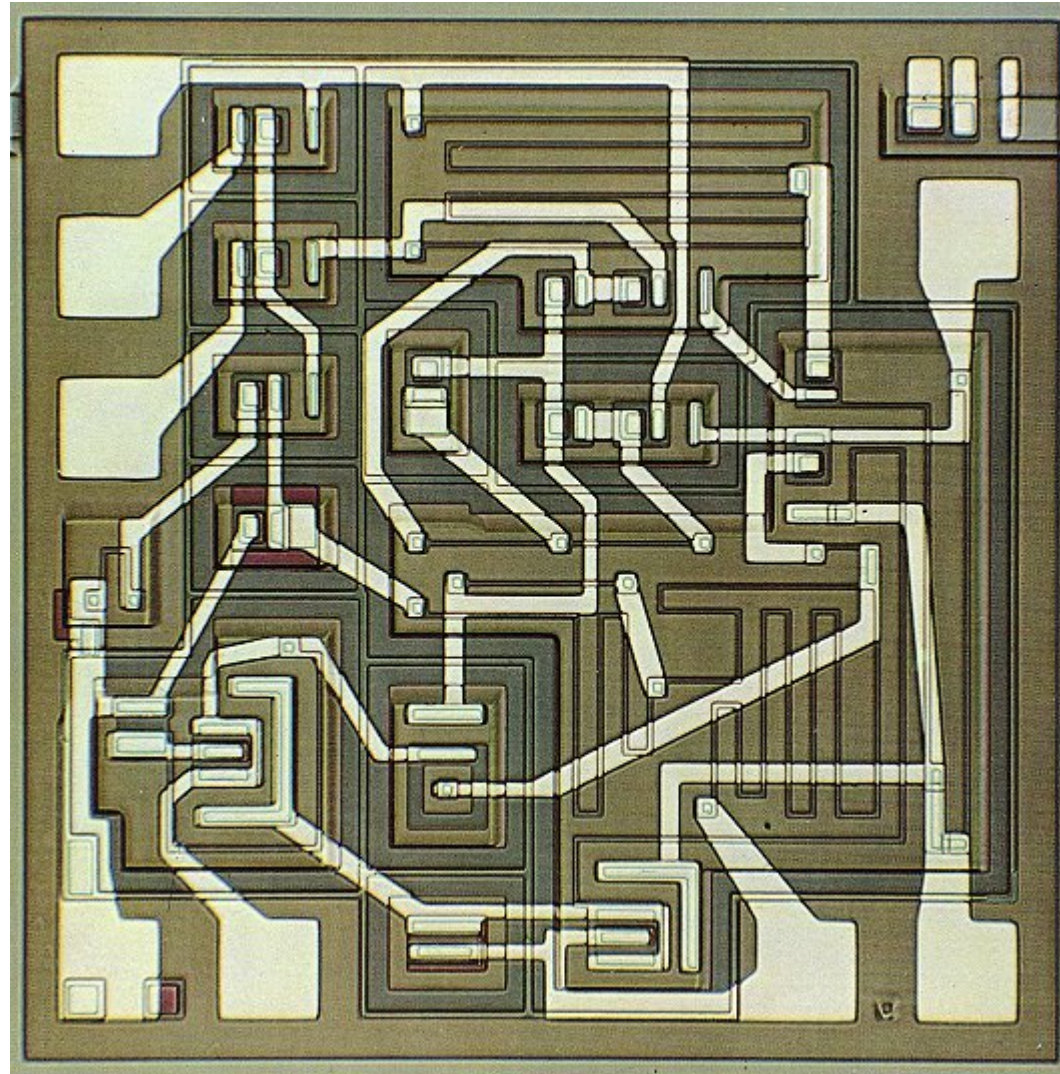
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Bob Widlar (1937-1991)

- μ A709, fotografía (1965)



Bob Widlar (1937-1991)

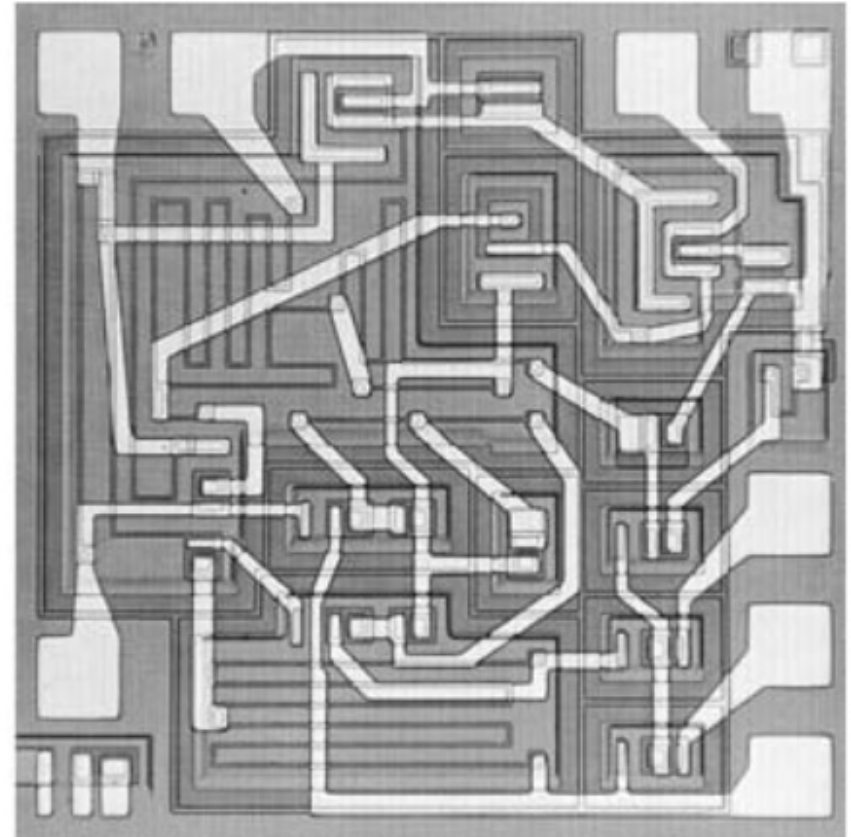
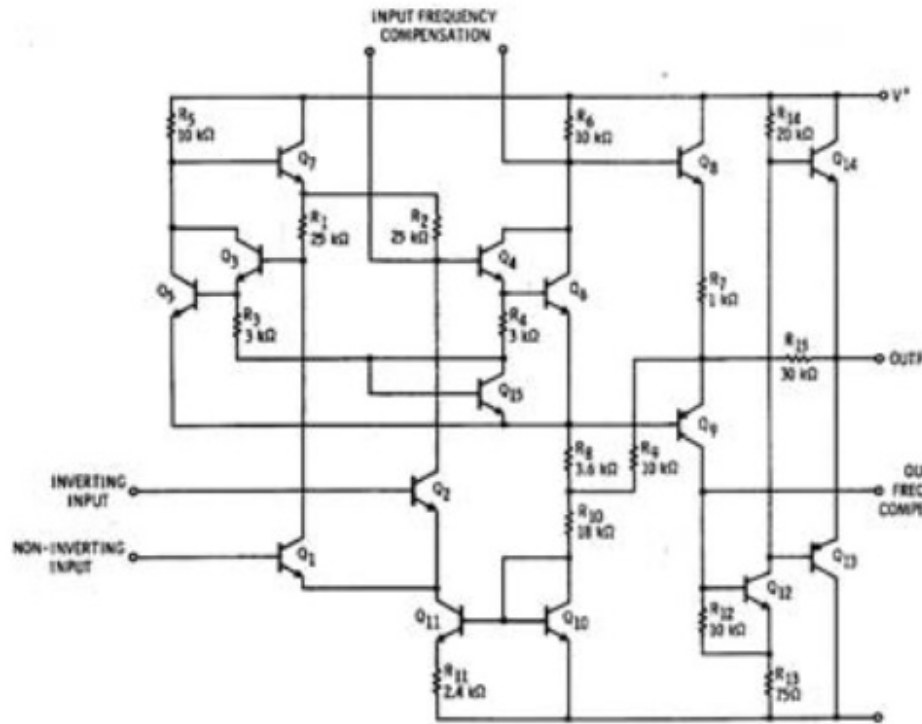
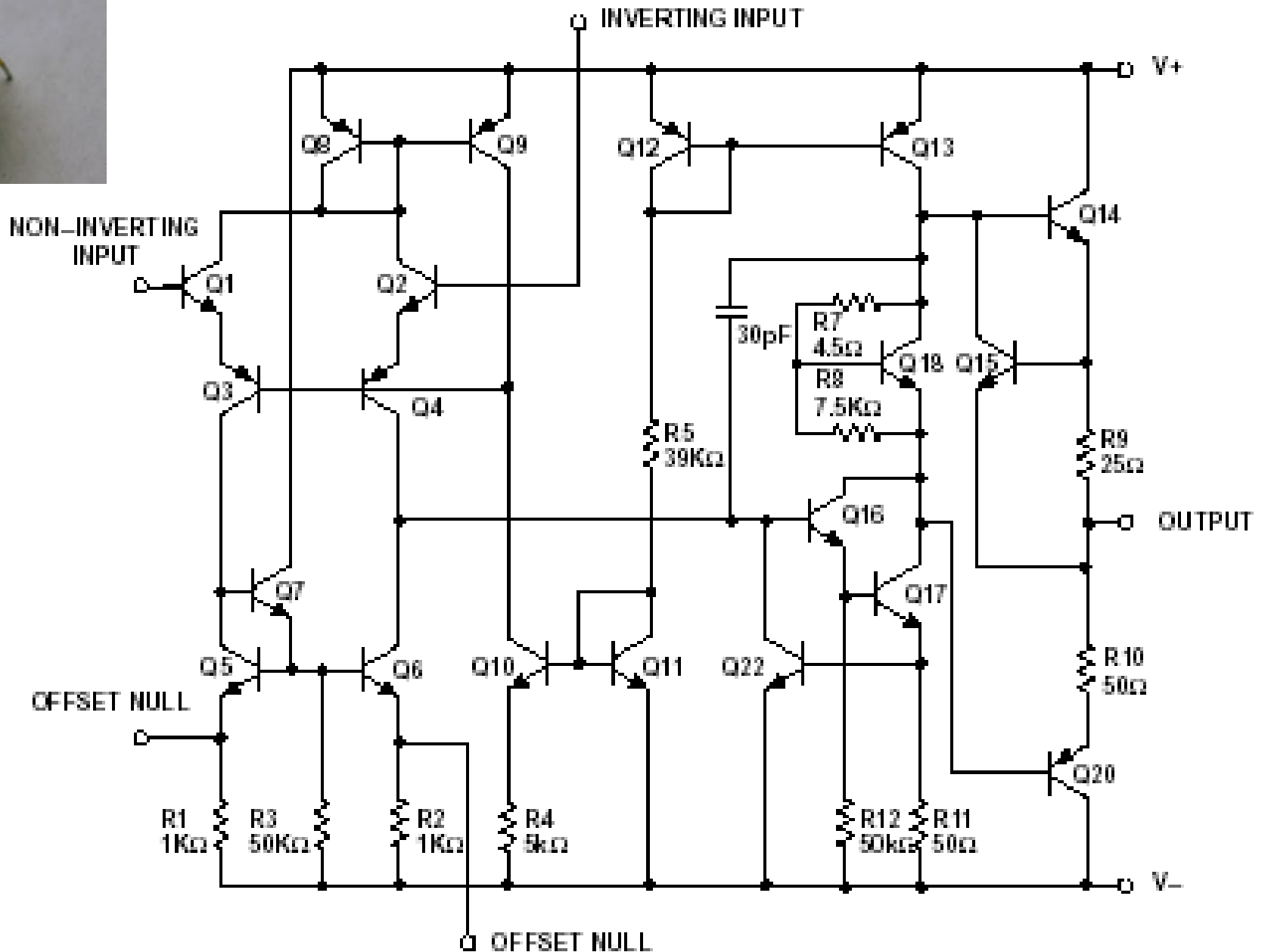


Fig. 8.25. The Fairchild Operational Amplifier $\mu\text{A} 709$ has fourteen bipolar transistors and fifteen resistors. Actual die size: $1880 \times 1880 \mu\text{m}$

De “History of Semiconductor Engineering”

Op-Amp $\mu A741$ (Fullagar, Fairchild 1968)

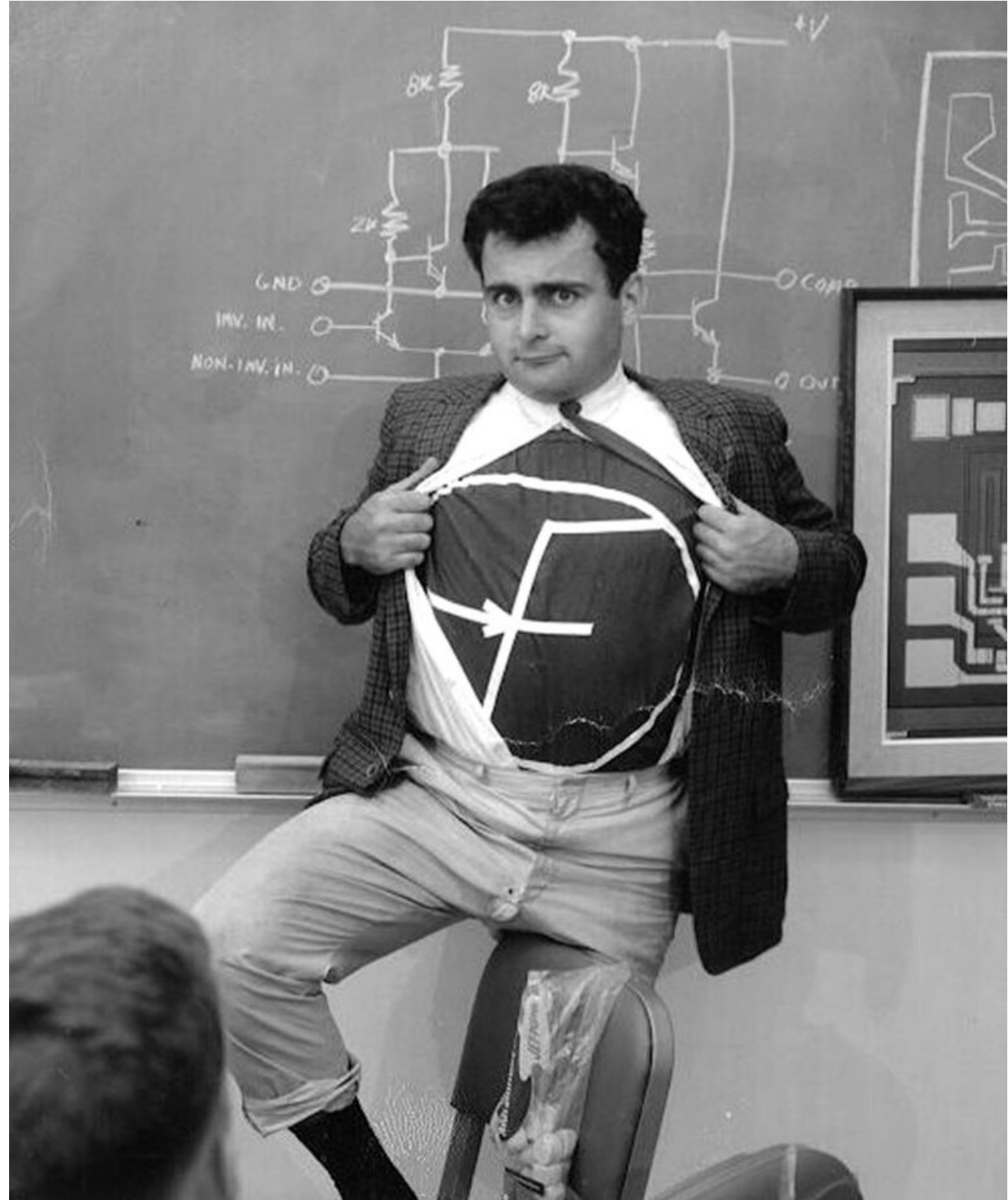


- Gran capacidad de “simplificación”.
- Crear reglas nuevas de diseño aprovechando las características de la integración.
- Trabajador incansable.
- Perseguía los detalles en cada etapa del proceso.



Foto: © Bo Lojek, “History of Semiconductor Engineering”, Springer 2006

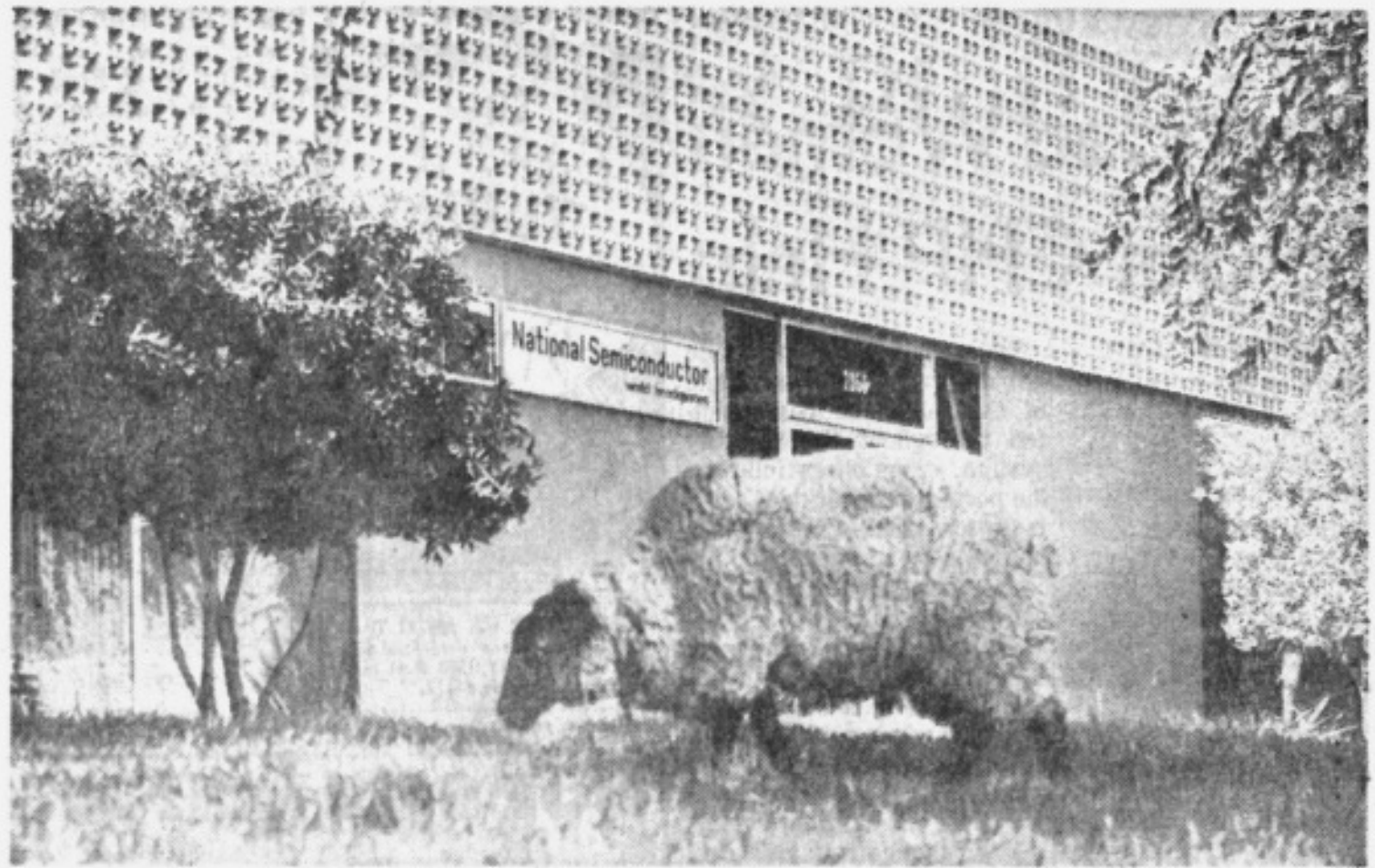
Según algunos
colegas y compañeros
de trabajo, era algo
excéntrico e
histriónico...



Era algo bromista

Economy Mowing

This is not Mary's little lamb grown up and following her to work. It is a lawnmower. Bob Widlar, director of advanced circuits development, "borrowed" the sheep for the front lawn of National Semiconductor in Santa Clara to help the firm's austerity program by cutting mowing expenses. Widlar admitted it is "putting a lot of gardeners out of work," but notes "at the same time the grass gets cut, it gets fertilized, too."



Era algo bromista

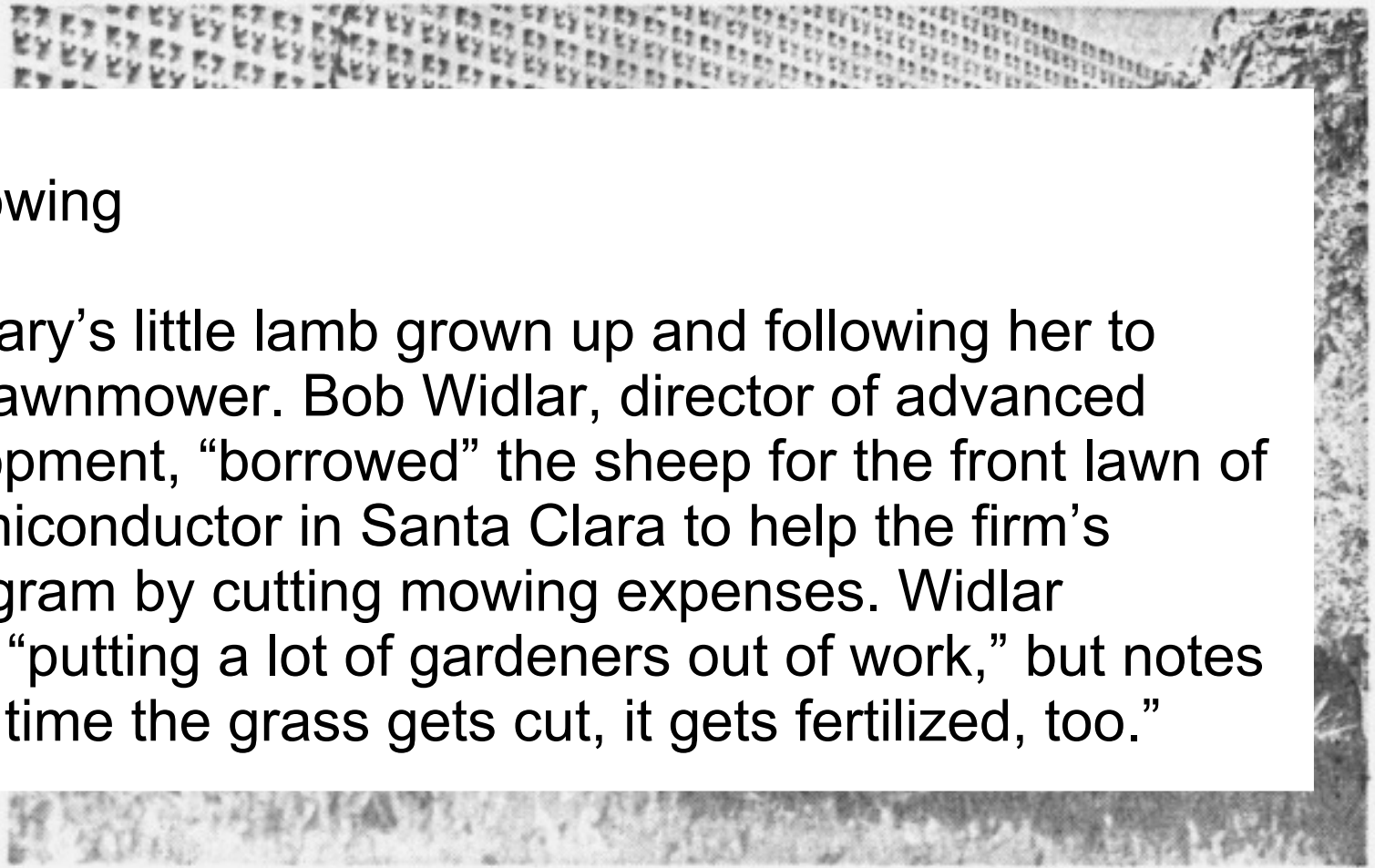
Economy

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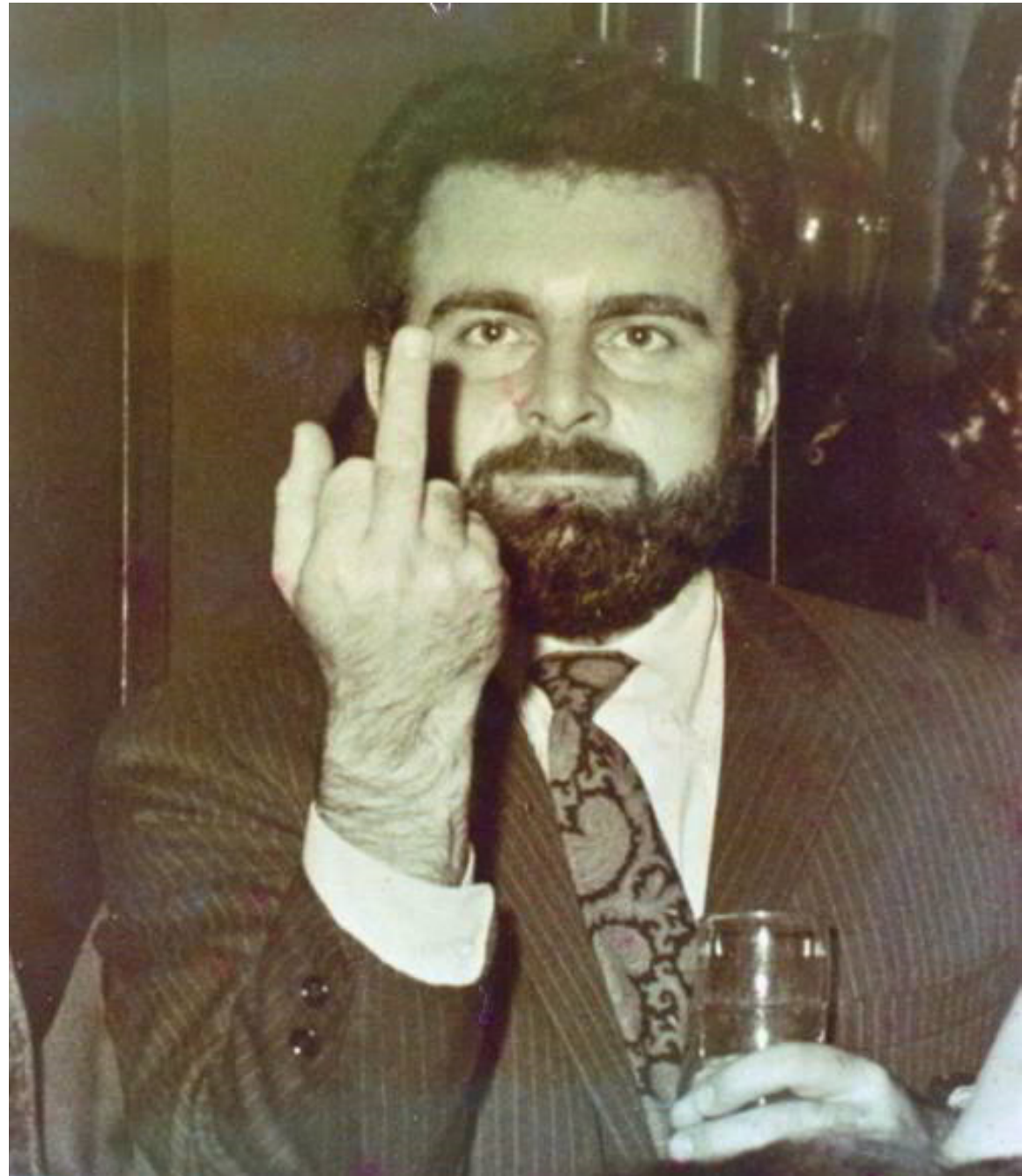
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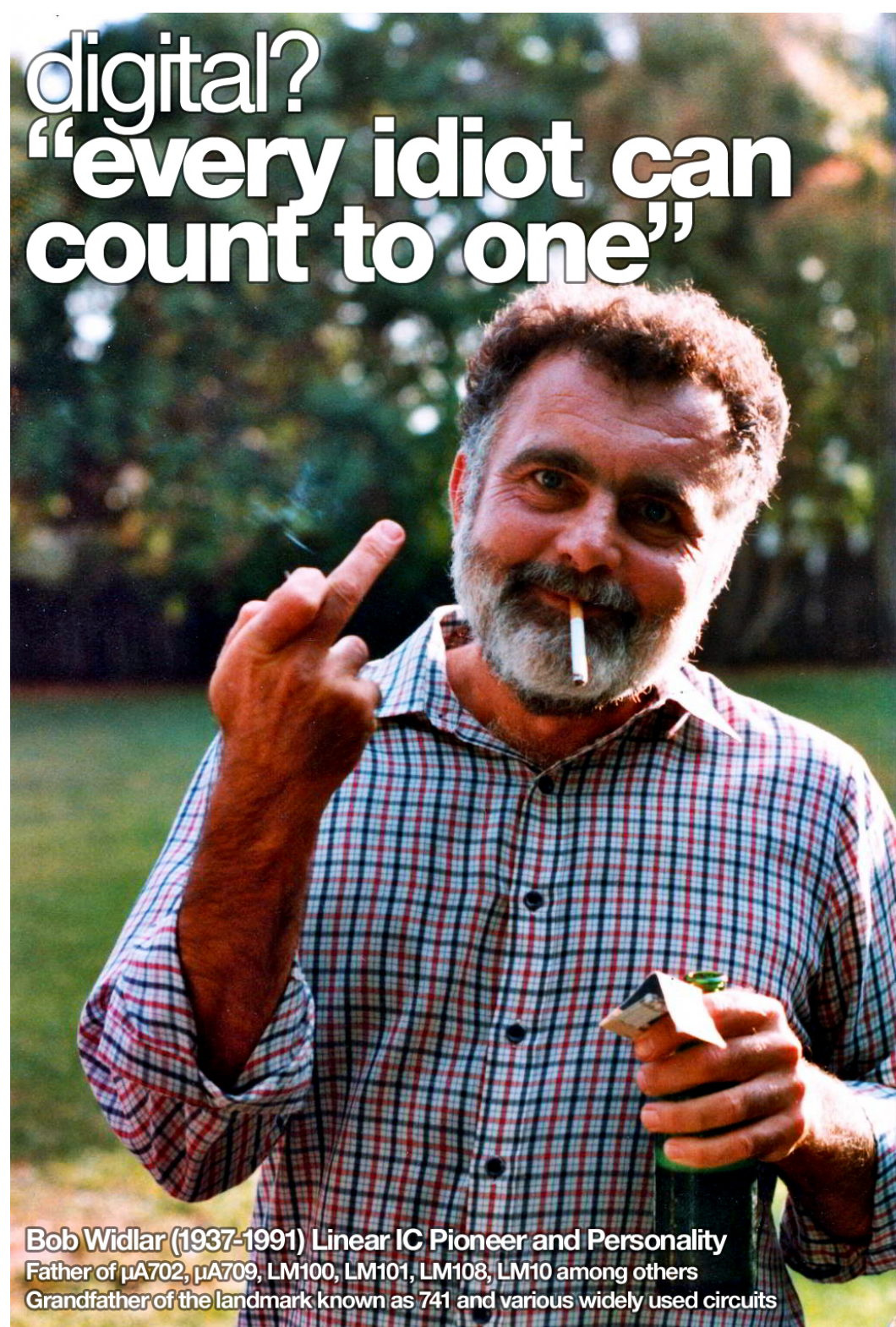
También tenía otro costado, temperamental...



Su gesto más
característico

Con opiniones muy firmes,
por ejemplo respecto los
circuitos digitales

digital?
“every idiot can
count to one”



Bob Widlar (1937-1991) Linear IC Pioneer and Personality
Father of μ A702, μ A709, LM100, LM101, LM108, LM10 among others
Grandfather of the landmark known as 741 and various widely used circuits

Era un momento de competencia durísima

Our message to the competition is simple and straightforward.

We've had it with namby-pamby blue sky advertising. From now on, National doesn't pussyfoot. We're going to take on the rest of the semiconductor industry and let the chips fall where they may.

We're the second largest manufacturer in just about every product category and we're going to let everyone know it.

We're also going to introduce some new products that will knock the competition right on their profit margins.

There are also a few things we're *not* going to do. We're not going to make a lot of products nobody needs. That's Signetics' job.

We're not going to introduce a new, hot-shot device that isn't even off the drawing board yet. Fairchild is much better at it anyway.

We're not going to promise a shipment for September that we couldn't possibly deliver before Christmas. That's TI's game.

And, we're not going to sit around on our ingots waiting for the second source business. Motorola's cornered the market on that one.

In short, we're going to be damned hard to compete with.

You know where nice guys finish.
National Semiconductor Corporation
2900 Semiconductor Drive, Santa Clara, Calif. 95051
Phone (408) 732-5000 / TWX (910) 339-9240

National



Era un momento de competencia durísima

- We're also going to introduce some new products that will knock the competition right on their profit margins.
- There are also a few things we're not going to do:
- We're not going to make a lot of products nobody needs. That's Signetics' job.
- We're not going to introduce a new hot-shot device that isn't even off the drawing board yet. Fairchild is much better at it anyway.
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- And we're not going to sit around on our ingots waiting for the seconds source business. Motorola's cornered the market on that one.

You know where nice guys finish.

Retorno

- A fines de 1974, decide trabajar periodicamente como consultor de National Instruments, combinando su retiro en Puerto Vallarta.
- Diseños muy importantes, p.ej.:
 - > LM12 power amplifier.
 - > Etapa de salida “Widlar” de bajo voltaje.
 - > LM10 ultra-low-voltage amplifier, capaz de operar con fuente de 1.1v (1978)

Aún en producción en el s.XXI. Durante 10 años no hubo otro diseño en la industria que alcanzara su desempeño.

- En 1981 funda “*Linear Technology*”, donde trabaja hasta 1984.
- Vuelve a National Instruments (1984 – 1991).

Referencia de voltaje 0.2v - Widlar subbandgap LM10 (1976)

